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THE SPIRIT OF THE LABORATORY[1]

By Professor CHARLES R. STOCKARD

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Why do we build a laboratory for physiological research? Because there have lived men like Theobald Smith. The discoveries and scientific advances made by such men have continually necessitated the building of new laboratories with more and more refined facilities in which other investigators might work to further widen the horizons of knowledge. Naming this the Theobald Smith Laboratory is dedicating it to one of the persons who greatly aided in its building. The Albany Medical College is to be congratulated on the realization of this fact, as well as on its peculiar right to adorn the building with such a name! Theobald Smith was a native son of this city, and the most distinguished graduate of the Albany Medical College. And it should be added, he probably was the most eminent contributor to medical science that this country has produced.

We may venture the fanciful conjecture that the earliest laboratory for physiological research was the Garden of Eden. Wherever this was, the story suggests that Adam tried out the effects of different plants as food for the human body and mind. These early instinctive experiments are still being performed by almost all members of the animal kingdom. But of all the animals, only Adam, with the valuable assistance of Eve, finally discovered the tree of knowledge and ate of its fruit. This food nourished the mind of Adam to develop beyond that of other animals, and he was driven out of the Garden and became capable of earning his bread by the sweat of his brow. The descendants of Adam ever since have been searching for this lost tree of knowledge, and though they have failed to find it they have learned much from the

[1] Address given at the dedication of the Theobald Smith Memorial Laboratory at Albany Medical College on March 19, 1937.

search. We are proud that the human race has gone a long way from the Garden of Eden, at least in some directions, and so to-day we are dedicating the latest laboratory for physiological research and teaching. However, the same old problem of the actions of foods and chemical substances on the functions of the animal body and mind is still the paramount issue to be studied.

What is meant at the present time by physiological research? Does this embrace a wide realm or a special field of study? Physiological research is the investigation of the functions and behaviors of all living arrangements: it includes investigations of the manner in which the ultimate life units or organic molecules exist with the power to induce the formation and multiplication of other units like themselves from the elements of their restricted environments. This power of self-synthesis is the fundamental feature of life. Physiological research includes studies of the genes within the chromosomes and their behavior in determining the constitution and the characters of the individual; it must reveal the miraculous processes by which the egg is changed into a fully formed child; it embraces considerations of the growth and differentiations which transform the child into manhood, as well as the actions and interactions of the organs, tissues and fluids of the adult body in maintaining its normal state; and finally, physiological research must include the study of the mysterious ways in which some arrangements within the brain give rise to consciousness and intelligence. Each and all these riddles are to be solved by physiological research founded on a sound background of morphology and allied sciences. The laboratory we are dedicating to-day will surely never have its activities restrained by the narrowness of its field for investigation. The subjects for study in this laboratory may actually include the behaviors of the investigators themselves.

The impulse to do research in its simplest form is a deep-rooted instinct. All young animals, including our own children, are curious and restless to become acquainted with their environments; this is a phase of the subconscious instinct for self-preservation. The desire to understand functions and behaviors is probably more nearly instinctive than is the interest in other classes of knowledge. From this supposition we need not infer that physiologists are necessarily more primitively minded than other persons.

The child's impulse to investigate its surroundings and learn about things is short-lived and is usually discouraged in most individuals during their stay in schools. It therefore becomes the primary necessity of a laboratory to create an atmosphere which will reawaken, stimulate and perpetuate the natural curiosity to learn, and thus promote the spirit for scientific investigation. The stimulus to do highly developed scientific research comes not alone from the essential "spark" within the investigator, but also from the inspiring spirit of the laboratory which fans this spark to its brightest glow. The laboratory must be invaded by that shy and intangible spirit which inspires enthusiasm and creates the devotion to research.

In building a new laboratory we have in mind two objectives. The one is material—a physical arrangement in which men may work and learn. Constructing such a plan is an ordinary accomplishment. Numbers of laboratories have been built in this country and in all parts of the world during the past few decades. Many of these structures are simple and modest, and others are elaborate and extravagant in both building and equipment. There is a broad possibility that modest buildings may well suffice for scientific work. The ingenuity of the investigator is not promoted by completely ready-made facilities. Discoveries of great scientific importance rarely if ever have come from palaces, but almost always from very simple surroundings. Few discoveries have been so fundamental in the advance of modern biology as the laws of heredity discovered by the monk, Gregor Mendel, in his monastery garden. The deductions which Darwin drew from studies made at his modest estate in England revolutionized the thinking of the intelligent world. Theobald Smith's discovery of the intermediate host in infectious disease and Walter Reed's experiments with yellow fever required very simple housing. Throughout the periods of history, monumental buildings stand more as final accomplishments than as markers of the beginnings of progress. In universities there has often been an exaggerated contrast between the grandeur of the laboratory buildings and the cramped conditions under which the family of an able scientist must live.

Solely from the standpoint of a new building for a laboratory there is little cause for rejoicing. But from the standpoint of the other element concerned in the creation of this building there is reason for great acclaim and enthusiasm. You intend not only to have the building, but you have proposed at its very beginning to induct into this laboratory the spirit of Theobald Smith. In so doing you have planned more wisely than you may know.

The creative spirit is the element most difficult to obtain and for that reason so often lacking within the atmosphere of laboratories. It has seemed to me appropriate, therefore, to devote my brief remarks on this occasion to that very strange thing—the spirit of the laboratory.

What do we mean by the spirit of the laboratory? Whence does it come, and how is it obtained? A

direct answer to these questions is almost impossible to give. However, we may consider them with some profit. Spirits are hazy things to describe. Their presence is realized by an appreciation of something in the environment that is not readily analyzable from the background of experience with our senses. A tour of several laboratories in different parts of the world may convey to you an idea of the thing which we hope is being introduced into this laboratory.

Some years ago there was established a tropical laboratory of marine biology on a small and isolated island in the Gulf of Mexico. The buildings were modest wooden shacks, and a small group of biologists were invited by the director to work in them. The workers slept in quarters adjoining the laboratory and ate in the same room that housed the aquarium. The temperature and humidity were uniformly high. Almost every piece of apparatus used was more or less improvised. Yet in the crudeness of this laboratory an inspiring spirit was present. Every one worked from dawn until darkness with a sense of joy in the doing.

The laboratory was new and without tradition or prestige; it was an affiliated part of the then new Carnegie Institution. Yet in spite of this newness, there was an atmosphere and a spirit that was quite inspiring and one continued to be enthused by this inspiration after years of absence from the place. The spirit emanated from the director, a simple, unassuming and unselfish person who made all feel that the laboratory would benefit greatly from their presence. The association was intimate, and the philosophy of the director peculiarly stimulating.

In the laboratories for marine biology built long ago by Anton Dohrn at Naples, there has been a spirit of inspiration from the start which has lasted for sixty years. Much of the history of modern biology might be written around this laboratory. Here Loeb started his studies in general physiology, and Wenckebach as a young student first observed the living development of the heart and vessels, and Wilson and Morgan and Driesch and many others did much to stimulate the early days of experimental embryology. Dohrn introduced a spirit, and a long line of workers in the same environment have kept it alive. The spirit here has not been due alone to one man but to the freedom of the place and the association of the workers.

The Marine Biological Laboratory at Woods Hole, which has been the great disseminator of enthusiasm for general biology and physiology in this country, is a prize locality for observations on the spirit of the laboratory. For years this laboratory had only the most primitive wooden buildings and little equipment. But the spirit was inspiring and the ingenuity of the investigators more than compensated for the inadequacy of apparatus. The high position which America holds in the field of experimental biology rests very largely on Woods Hole. The laboratory buildings are now all that could be desired, with modern equipment and apparatus. But the spirit and manner of the place have remained the same, as nearly as a large place can possess the properties of a small. The spirit at Woods Hole comes from many persons working together in free association. It is a scientific democracy and the "director" neither dominates nor directs. At the opening of one of the new laboratories Mr. Charles R. Crane, a wise benefactor, remarked that the most valuable element of these laboratories was the spirit that had existed within them. Presidents of universities and directors of various laboratories have come to Woods Hole to learn what makes the spirit here. They hoped to catch such spirit for their own institutions. Mr. Crane's wish was that the spirit would not shy away from the new buildings but would remain to find in them an agreeable home.

The laboratories thus far mentioned are peculiar in that the investigators working in them are not employed to do research. These persons come on their own account for the opportunity to work, and their relationships and associations are different in ways from those of members of a laboratory staff. Yet the rare spirit we are pursuing does not always dwell even in laboratories of this type. There are some such laboratories in which the true spirit of research has never been expressed, though able investigators may have worked in them.

We turn now to laboratories closer to the kind being dedicated to-day: the scientific laboratories in the departments of the medical faculty in universities. Some years ago in the German university at Munich one of the scientific departments was housed in the most perfect physical plant that any institute of this particular kind then possessed. The building and its arrangements were famed throughout the world. There was a large staff and much activity, but the atmosphere was not inspiring and the spirit of research was weak and sickly. The soul was absent. Another biological laboratory in this university was located a short distance away in an old and dilapidated building. The staff was smaller. But the spirit of inspiration in this laboratory was so great that students came from all parts of the world to be stimulated by it. The spirit here seemed to radiate from a small, simple man with a proud but kindly interest in the scientific investigations of all students. He knew all the investigators who visited his laboratory and encouraged every one with scholarly enthusiasm.

The spirit of scientific research has flourished in an unusually conspicuous manner in the small Bavarian

University of Würzburg. Here in the ancient anatomical pavilion in the garden of the Julius-Spital, Albert von Kölliker at thirty years of age began, as professor of anatomy and physiology, to lay the foundation and build almost the entire subject of modern histology, and to add much to the physiology of the tissues. In this same pavilion Rudolph von Virchow, while in his thirties, developed the field of cellular pathology. Kölliker moved into a new and larger laboratory of anatomy, where his studies continued to rapidly expand, outgrowing this second laboratory, which was later used as an institute of hygiene. The third anatomical institute occupied by Kölliker still serves as a splendid laboratory of anatomy which after him has been directed by Stöhr, Oskar Schultze and Braus, all eminent investigators. Kölliker spent fifty-eight years of his long life in the small University of Würzburg, declining the many offers which came to him from universities in three different countries. The spirit of these laboratories has been so permeating that an almost lasting inspiration is derived from it. In the physics institute, two buildings away from Kölliker's Anatomie, Roentgen discovered the x-ray in 1895, and in the building across Kölliker Strasse, Boveri did much to lay the basis of experimental cytology and Spemann began his classical studies in experimental embryology. A host of eminent workers have passed through these laboratories and have been imbued with the scientific spirit which pervades them. However, other laboratories of the same university have been unable to entice the spirit to dwell within them, and some have actually lost the spirit they once possessed. The recent director of the fine new pathological institute would on occasion exhibit the crude old desk at which Virchow first wrote his cellular pathology, but the visitor's reaction was usually one of pity that such a desk should be in so spiritless a place.

No university is so fortunate as to be good in all departments, but to be worthy of the name, a university must have at least one department in which the spirit of research resides.

Returning to our own country, many of us know of laboratories which have this spirit—laboratories where persons work with joy and zest. But they are not all in the largest universities nor in the most elaborate buildings. Some are in small and simple places. Still we ask—what is the spirit? One laboratory in a research institution may have it and another may not.

The spirit of a laboratory may arise from one man or it may come from several. It may or may not radiate from a man of great eminence. It may emanate from a man who is neither great nor eminent. One thing seems certain: the spirit comes from a simple man; not from a pompous or proud person; but from a generous and open-minded man willing to hear opposing sides and to stimulate different points of view. In the laboratory there should be no effort to suppress opinions, but an open consideration of all problems worthy of discussion. The laboratory should not be a sanctuary for the worship of authorities or heroes, but a free dwelling for students of nature conscious of and charitable to the faults and virtues of those that surround them.

The spirit dwells in the laboratory where there is a sense of proportion. When one idea is exaggerated at the expense of another, natural harmony may disappear and the spirit vanish. As Professor Pupin once said, every scientist must have a keenly developed sense of proportion. And, he added, they usually do—except when it comes to the proportion between the size of their families and the size of their salaries. The laboratory spirit, like ghosts of the night, is a fleeting and tenuous affair. It never exists where time and routine are important. It disappears with an eight-hour day or a six-day week or a nine-month year. The atmosphere is inspiring only where all time belongs to the spirit of science.

In a laboratory of physiology, teaching and research are an almost inseparable pair. One who teaches and does not investigate the problems of his subject becomes a pedant dispensing knowledge only at second hand. Association with students and younger investigators freshly approaching their problems stimulates the more experienced investigator and keeps him alert to the uninitiated points of view. Scientists who spend their time in purely research institutions and do no teaching have not always gained recognition on the basis of their contributions any earlier in their careers than have some of those who have taught while doing their research. One of our wisest university presidents once said that a man need not be given free time for research; if other duties took all his time he would still find chance to do research if he had the spark to do it.

A laboratory should be a home in both the proprietory and time-forgetting senses of the word. In the laboratory one must be completely at ease and feel that it is there he belongs. It is not a place to go to work, in the drudgery sense of that word. The laboratory is a place for the joy of learning in which one should always remain a schoolboy with nature as the only true teacher.

This laboratory has the great future of physiology before it. To appreciate what the future may hold we need only look back on the recent past to the beginning of the century when deficiency diseases were dark mysteries and vitamins were unknown; when the study of the internally secreting glands was

just beginning; when the constitution of the cells and tissues on the basis of their genetic nature was a blank page, and the mind-body relationship was almost entirely mystical; and when the question of whether vitalism or mechanism was the basis of physiological processes was a subject of serious debate. We need strength and courage to dare dream what the next thirty-seven years may bring and to realize how crude and even false many of the scientific positions of to-day may then seem.

The new laboratory is a new home for physiologists. It has all the future of this science within it. Who can say that the greatest discovery may not happen there; the arrangements which bring forth life itself must some day be found in some laboratory. May all those who work in this laboratory be inspired by the spirit of Theobald Smith, and with a quiet modesty may they whisper their questions to nature, and if she answers, may they have the simplicity to understand.

AGRICULTURAL RESEARCH IN CHINA.[1] II

By H. K. HAYES

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Entomology: Courses in entomology are taught in each of the agricultural colleges previously listed and courses are given also in the private colleges of Yenching University, the Peiping Union Medical College, the Soochow University, the Chen Tan University and in Fukien Union College. Research work of various sorts is carried on at most of these institutions. Mr. F. C. Woo, head of the department of plant pathology and entomology of the National Agricultural Research Bureau, furnished a list of entomological workers in China. This list consisted of 26 professors, 4 assistant professors, 11 instructors, 17 senior entomologists, 7 assistant entomologists and 12 assistants. This list of 77 workers in entomology, many of whom have had advanced training, gives some idea of the status of entomology in China. It should be appreciated that in entomology and other fields of agricultural research there is a large body of students who have graduated from middle schools, and other schools of a similar nature, and who make admirable assistants but who have not been listed in this survey.

Several special schools have been conducted for the purpose of training research assistants and extension workers. A one-year short course was held by Southeastern University in 1928–29 and 20 students completed the course work. The Bureau of Entomology of Chekiang conducted a similar training school for each of three years from 1931 to 1934 and 87 students completed the short course. In 1936 the National Agricultural Research Bureau conducted a National Training School for Insect Control. Eighty-seven technical workers or agricultural school teachers from 15 provinces were in attendance.

The first application of scientific methods for the control of insects in China, since the formation of the Republic, was in 1919 when private funds were given at the request of Dean Tsou, of Southeastern University, to aid in controlling an outbreak of the cotton looper. A few years later the Kiangsu Provincial Bureau of Entomology was established at Southeastern University, now called Central University.

In 1924 the Chekiang Government established a Bureau of Entomology, which was located at Kashing but moved to Hangchow in 1934. This laboratory has made many important studies of injurious insects, has an extensive insect collection and a good library. The provincial governments of Szechuan, Kiangsi, Kwangtung and Honan have Provincial Departments of Entomology connected with their local departments of agriculture.

The Entomological Department of the National Agricultural Research Bureau consists of six experienced entomologists, one senior chemist and fourteen assistants. Studies of the rice borer and of stored-grain insects are conducted in cooperation with the National Rice and Wheat Improvement Institute. Other research studies are carried on with the migratory locust, forest insects and insecticides. The most important contribution of this department in cooperation with the Cotton Improvement Institute is the invention of cotton-seed-oil emulsion for aphis control. The new insecticide is more satisfactory and the cost is only about one third as great as kerosene oil emulsion.

This brief summary gives some idea of the status of entomology in China and indicates rapid development of this important field in recent years.

Horticulture: Several of the agricultural colleges have departments of horticulture. The more important of these are the Colleges of Agriculture of the Universities of Nanking, Chekiang and Lingnan, the Hopei Provincial Agricultural College and the Northwestern College of Agriculture at Wukung. Horticultural crops in China are of great importance and China is particularly fortunate in the large variety of

[1] Address of the vice-president and chairman of the Section on Agriculture, American Association for the Advancement of Science, Atlantic City, December, 1936.

vegetable crops that are so widely grown. The more extensive experimental work with some farm crops, as with wheat, rice kaoliang and millet, than with most horticultural crops is without doubt due to the necessity of increasing the supply of food of those crops that represent the basic food supply of the nation. As time and funds permit it may be expected in the near future that the work with horticultural crops will be greatly expanded.

Citrus fruit crops have been worked with extensively in Chekiang, Fukien, Kwangsi, Kwangtung, Hopei and Kiangsi. Varietal surveys and storage problems have received the most attention. Varietal surveys with peaches have been made in the provinces of Chekiang, Kansu and Shantung and the better varieties have been learned. The problem of deastringing persimmons that belong to the astringent group has been worked out.

With vegetable crops extensive breeding studies are under way at the University of Nanking with varieties of radish and cabbage. Studies of watermelon have been made in several provinces with particular reference to varietal differences, cultural methods and the breeding of improved varieties. Cultural studies are being made with orchids at the University of Chekiang, and propagation and classification studies have been made with shrubs and trees at the Lushan Arboretum and Botanical Garden in Kiangsi.

Many of the larger cities in China have well-developed park systems, and the work in these parks along horticultural lines is rather extensive. Studies of varieties of fruits, such as watermelons, peaches and pears, and of ornamentals, like chrysanthemums, peonies and roses, are of great value in varietal surveys and in education of the public.

Forestry: According to D. Y. Lin,[7] who discussed forestry in the Chinese Yearbook, regular college courses in forestry are given at Nanking University Peiping Agricultural College and the Agricultural College of Central University. Special courses in forestry are given also at several agricultural colleges in the provinces of Chekiang, Honan, Anhwei, Kwangsi, Szechuan, Hopei and Kwangtung. The Northwestern College of Agriculture and Forestry at Wukung has been organized recently.

Under various provincial bureaus, such as the bureau of reconstruction, the bureau of industries or the office of forestry, extensive work is under way in most of the provinces. The budget for this work is over one million dollars annually, the total number of district forest stations is 80 and the number of technical trained men at these stations is 118.

The Central Afforestation Bureau organized in 1929 by the Central Government has set up a model forestry area around Nanking and over fourteen million seedlings have been set out.

The National Agricultural Research Bureau has a department of forestry with 6 research workers. Experiments are conducted at the bureau in cooperation with the Sun Yatsen Memorial Park, where experiments are being made on reforestation. Studies of forest plantings are being made with the College of Agriculture of Honan University and the Chan Shan Provincial Forest Station of Chekiang.

Animal Husbandry and Veterinary Science: In an article on animal husbandry in the Chinese Yearbook for 1935–36 Mr. Vougi Tsai[8] makes the statement that "China ranks second in the world animal industry." An estimate of number of units of live stock in 1935 was made in "Crop Reports" by the National Agricultural Research Bureau.[9] This includes the provinces of Chahar, Suiyuan, Ninghsia and Tsinghai and 17 provinces in China proper but lacks data for the province of Kwangsi. These data then include the numbers of units of live stock for 1935 for 21 provinces (see Table 4).

TABLE 4

UNITS OF DIFFERENT KINDS OF LIVE STOCK (UNIT, 1,000 HEADS)

Productive animals		Labor animals	
Kinds	No. units	Kinds	No. units
Sheep and goats	42,890	Water buffaloes	11,603
Hogs	62,639	Oxen	22,647
Chickens	246.688	Horses	4,080
Ducks	56,724	Mules	4,666
Geese	10,538	Donkeys	10,547

It is apparent that animal industry is of great importance in China. It should be remembered, except for a few provinces, that crops are raised primarily for human consumption and that by-products are used as fodder. In general there is little use of hay and pasture crops and except in the region of larger cities no dairy industry. In Northwestern China there is a large area of grazing land, and alfalfa is grown rather extensively in certain sections. Wool production is the principal animal industry in this region.

Several of the agricultural colleges have departments of animal husbandry. These are found at Central University, Nanking; Sun Yatsen University, Canton; Honan Agricultural College, Honan University; the Agricultural College of Peiping University; Northwestern College of Agriculture, Wukung; the College of Agriculture of National Szechuan University and the Institute of Kansu, with a Junior College of Agriculture and courses both in animal husbandry and veterinary medicine.

Veterinary schools comprise: (1) the Army Vet-

[7] D. Y. Lin, "The Chinese Year Book," pp. 769–785, 1935–36.

[8] Vougi Tsai, "The Chinese Year Book," pp. 786–805, 1935–36.

[9] Nat. Agr. Res. Bur. China, Crop Reports. Vol. IV, No. 4: 115–118. 1936.

erinary School, under the Ministry of War, with over 30 years' history. Seventeen classes consisting of approximately 500 students have graduated from this school. (2) The Technical School of Veterinary Science at Shanghai, organized in 1932, which gives two years' college training to middle school graduates. The first two graduating classes consisted of about 60 men, most of whom obtained positions immediately. (3) Central University, giving a four-year course, from which approximately 20 men have graduated.

In animal husbandry improvement projects with swine are carried at Central University and at Sun Yatsen University in Canton. The studies at Central University comprise a multiplication of several foreign breeds for extension work, including Large Yorkshire, Berkshire, Hampshire and Poland China and studies on the growth rate of Chinese breeds of swine, while grading up of Chinese breeds is being studied at Central University and at Sun Yatsen University. Breed characteristics of the Peking duck and fattening projects are under way at Central University as well as studies of grading up of Chinese cows for improvement of dairy characteristics by the use of Jersey sires. The milking quality of the Chinese water buffalo has been studied for years at Lingnan University, Canton. With liberal feeding some animals give 4,000 pounds of milk per year with a fat content of from 10 to 15 per cent.

At provincial stations in several provinces there are improvement projects with live stock. The Szechuan Bureau of Animal Industry is carrying on studies with swine and sheep breeding, and the Chekiang Provincial Station recently has started a project on swine breeding. The Kiangsi Provincial Bureau has a department of animal husbandry and is making studies on swine grading, poultry improvement and with the Peking duck. The Kwangtung Provincial Bureau of Agriculture is studying swine improvement. Under the Ministry of Industry there is a Northwestern Breeding Station working chiefly on sheep, while the Ministry of War has an extensive horse-breeding station, where studies are made also of disease control.

Much of the live stock of China has become adapted to particular conditions of environment through long years of selection and while inferior to foreign breeds in many respects it is generally believed that the native breeds are hardier and better adapted to local conditions than introduced breeds. For these reasons it appears feasible to grade up native breeds through crosses with foreign breeds rather than introduce foreign breeds for direct use.

The department of animal husbandry and veterinary science of the National Agricultural Research Bureau under the Ministry of Industry has a force of two senior veterinarians, one bacteriologist and five veterinary assistants at the Central Station in Nanking and two field stations, one in Kiangsu and the other in Chekiang Province, with one senior veterinarian and five assistants. Ten different kinds of serum, vaccine and diagnostic reagents are being produced. Anti-hog-cholera serum is being produced on a large scale to supply field stations for hog cholera control. Special attention is being given to the development of serums and vaccines and special research studies are being made of important diseases of animals.

There is a serum laboratory at Tsingtao in Shantung Province under the Ministry of Industry and a Northwestern Epidemic Prevention Bureau for the control of human and animal diseases. Several provinces have provincial bureaus where studies are carried on for the control of diseases. The Kwangsi Provincial Bureau of Animal Husbandry is producing rinderpest serum and vaccine on a large scale and has as its aim the eradication of rinderpest in the province. The Agricultural Institute at Nanchang in Kiangsi Province is developing a comprehensive plan for the control of animal diseases and is manufacturing serums for provincial use. The Szechuan Provincial Bureau of Animal Industry and the Kwangtung Provincial Bureau of Agriculture have project work on the control of animal diseases.

A partial picture of the status of animal husbandry and veterinary medicine in China can be gained by summarizing the number of men in teaching and research with a college degree. Disregarding the Army Veterinary School at Shanghai and making estimates for those institutions where the number of assistants was not known would give 8 professors and 16 assistants in animal husbandry in colleges giving courses and carrying on research in animal husbandry and 4 project leaders and 14 assistants in provincial departments carrying on research in animal husbandry.

In veterinary medicine there are approximately 5 professors and 8 assistants in college departments, 4 project leaders and 14 assistants in provincial departments and 7 project leaders and 14 assistants in departments under the control of the National Government. To this list must be added a large number of assistants who are graduates of middle schools and who have had special training in short courses.

This seems to be a relatively small number of research workers in animal industry in proportion to the value of the industry in China.

Sericulture: Some time ago raw silk was of first importance in China's export trade. While the rapid decline in the value of raw silk exports in recent years may be due largely to world-wide depression, the value of the industry in China has led to extensive and intensive studies for the improvement of the silk industry.

The Department of Sericulture of the National Agricultural Research Bureau, Nanking, with 6 project leaders, is centering its attention on the improvement of silkworms by breeding, using methods that rather closely parallel those which have been used successfully in the United States with corn. Diseases and parasites and their control are being studied also as well as varietal trials of the mulberry tree.

There are departments of sericulture at the National Central University, the University of Nanking, National Chekiang University, National Sun Yatsen University, Lingnan University and Liao Chung Kai Agricultural and Industrial School, Canton. At these institutions there are 16 project leaders working with silkworms. The breeding of silkworms is being studied at all 6 schools, the genetics of silkworms at 2 schools, diseases at 3 schools and varietal trials with the mulberry tree at 2 institutions.

The Provinces of Kiangsu, Chekiang and Szechuan have sericultural experimental stations, with 5 project leaders. All three stations are studying silkworm breeding, while the stations in Kiangsu and Chekiang are making varietal trials of the mulberry tree. Diseases of silkworms are being studied in Szechuan Province. Several of the provincial stations are distributing silkworm eggs to the growers. Thus in the provinces of Kiangsu and Chekiang more than three million sheets of improved eggs were used in 1934.

In addition to the above institutions and experiment stations the International Committee for the Improvement of Sericulture is carrying on a silkworm breeding project and the Bureau of Sericulture in Canton is making studies on the uses of silk, the control of diseases and the breeding of improved varieties.

The Sericulture Improvement Committee of the National Economic Council, organized in 1934, has extensive studies under way for the improvement of all branches of the silk industry.

The provinces of Szechuan, Chekiang, Anhwei, Hupeh, Shantung and Kiangsu have extension bureaus for sericulture. The most important phase of their work is the distribution of improved disease-free eggs, a total of over one hundred thousand cards of eggs having been distributed. Other phases of work in some provinces include the distribution of improved mulberry trees and the organization of cooperatives for the sale of farmers' products.

Other research fields: In addition to the lines of work mentioned already, probably the most important other phase of agricultural research in China is in agricultural economics. The studies of Dr. Buck at the University of Nanking are well known. This work is being continued on a large scale, is well supported and is making available to workers in other countries an accurate picture of farming conditions in China. It is helping, also, to make known some of the important farm problems and is aiding in their solution. The Crop Reporting Service of the National Agricultural Research Bureau, inaugurated in 1933, is of great value in making available statistics of crop production.

According to statistics made available by W. S. Tong, of the Department of Agricultural Economics of the National Agricultural Research Bureau, there are four colleges or universities that have special departments of agricultural economics, and courses in agricultural economics are given in 18 other colleges or universities. To date 121 graduates have majored in agricultural economics, including students from the University of Nanking, National Peiping University and National Chekiang University. In addition to the University of Nanking and the Research Bureau, already mentioned, twelve other institutions are conducting research on agricultural economics.

Research along agricultural engineering lines is being developed at several institutions, although work in this field has not been undertaken to any great extent.

CONCLUSION

The rapid expansion of agricultural research in China in recent years is one indication of the widespread interest among Chinese leaders in improving the living conditions of the people. The present tendency is to work primarily on problems of an immediate practical importance. With the basic farm crops the immediate end in view is to make China self-sufficient. There is, however, in China a growing appreciation of the value of agricultural research as one means of helping to develop efficiency in agriculture.

OBITUARY

JAMES BERTRAM OVERTON

NEWS of the death, on March 18, of Professor Overton came with a shock to a wide circle of close friends, and particularly to the many who have worked with him as students.

James Bertram Overton was born at Richmond, Michigan, on October 23, 1869. His graduation from the University of Michigan in 1894 was followed by a year of high-school teaching at Black River Falls, Wisconsin, and this by three years as senior master in mathematics at St. John's Military Academy, Delafield. In 1898 he began graduate work at the University of Chicago, where he received the degree of Ph.D. in 1901.

For the following two years he served as professor f biology at Illinois College, Jacksonville, which stitution later (in 1930) gave him the honorary deree of Sc.D. The year 1903–4 was spent in Strasurger's laboratory at Bonn, under appointment by he Carnegie Institution of Washington as research ssistant. In 1904 he came to the University of Wisonsin as instructor in botany. Here he remained, eing successively assistant professor of botany 1907), associate professor of plant physiology 1912) and professor of plant physiology (1915).

On December 26, 1901, he was married to Mary E. Cochran, of Ashland, who with one son and two aughters survives.

Overton's work with *Thalictrum purpurascens* was ne of the very early studies of parthenogenesis in lants. In this species he first demonstrated that arthenogenesis occurs, and then determined the deails of the cytological history which supplies an xplanation of the phenomenon. Following this came series of studies of meiosis, spore-formaton and uclear organization. Gradually his attention was urned to the experimental phases of physiology, in which his interest had been aroused while working with Barnes and Loeb at Chicago. In this field falls is successful induction of parthenogenetic developent under controlled conditions in *Fucus*, a piece of work which recalls his previous study of *Thalictrum*. Most extensive of his physiological investigations were hose dealing with the course of the sap flow and with its determining and regulating factors. Part of this work was done at the Tucson and Carmel laboratories of the Carnegie Institution of Washington, where, as research associate, he spent parts of each year from 1925 to 1929. The outcome of these years was a series of studies, published in conjunction with Dr. D. T. MacDougal and Dr. G. M. Smith. At this time also Overton began a study of the structure and history of the long-lived cells which had been found by MacDougal to occur in the stems of certain cacti.

Reference has been made to Dr. Overton's wide circle of friends and acquaintances. His unusually extensive acquaintance was an outcome of his deep interest in human problems and of the capacity for friendship which was one of his notable traits. Somewhat the same type of interest was manifested by his activities in connection with the scientific and other organizations of which he was a member. A fitting recognition of his services in this direction was the award in 1933 by the American Society of Plant Physiologists of its Charles Reid Barnes life membership. He was a regular attendant at scientific meetings until the precarious state of his health in more recent years had made travel, especially in the winter, dangerous and often impossible. Despite frequent illnesses, however, he retained so much of his old-time vigor, and was so active in the interims of comparatively good health, that there was no premonition in any mind of the end that finally came so suddenly.

CHARLES E. ALLEN

SCIENTIFIC EVENTS

THE STANDARDIZATION BUILDING FOR THE BUREAU OF AGRICULTURAL ECONOMICS

A NEW six-story building has been made available for the Bureau of Agricultural Economics to house many of the research activities centering about the standardization of farm products. It will be devoted particularly to standardization and research in cotton, wool, hay, seeds, beans, peas and soybeans. It contains more than seventy-five offices and laboratories equipped for intensive study of the properties and qualities of these products. In addition, it provides warehouse space for more than 1,000 bales of cotton, 600 bales of hay and large quantities of wool, which will be stored under conditions in which fire hazards have been reduced to the minimum. Every effort also has been made to provide for the fullest possible protection of fiber standards employed internationally in world trade of cotton, research records and technical equipment. Special emphasis has been given to provide the best possible natural lighting for grading and classification work and for intensive research related to fiber properties, including color.

On the top of the building is a group of classing rooms for cotton and wool with slanted skylights facing the north. These rooms were designed to be shadowless. They provide lighting conditions which have been found essential in judging color, diameter and other factors in grading fibers. Cotton, wool and hay produced in all areas of the country, and to some extent in foreign countries, will be sampled, classed and graded in connection with the program of evaluating properties and qualities.

Fireproof doors and automatic sprinkler systems in the warehouse section, which may be isolated from the offices and laboratories, are safeguards against the extreme fire hazard. By day and by night all parts of the warehouse will be under constant watch.

Scientific research in the new cotton laboratories will include studies of cotton staple length in relation to staple classification and standardization, the relationship of cotton color to grade classification and stand-

ardization, new uses for cotton, the preparation of cotton for the market, and studies of cotton seed and cotton seed products. The building has a scientifically constructed hay laboratory and warehouse where workers will study hay quality standardization factors. Studies will be made to develop improved methods of determining factors of quality in beans, peas and split peas. Research on wool will include the study of ways to improve methods and practices in the preparation of wool for market and the standardization of wool for length and strength of staple. Experiments will be conducted to perfect a reliable method of determining the shrinkage of wool.

The Standardization Building will be the headquarters of the market news services for cotton, grain, hay, feed, seeds and a number of other farm products. It likewise will be the headquarters for the South-wide cotton quality reporting service involving the issuance of cotton grade and staple reports on the growing crop.

In the new building government standards for the various commodities will be prepared, and the cotton appeal board will function in settling trade disputes over classifications of cotton according to the standards.

PROPOSED WILDLIFE CONSERVATION INSTITUTE AT THE UNIVERSITY OF WISCONSIN

Establishment of a Wildlife Conservation Institute, composed of four divisions, under which the University of Wisconsin would utilize every opportunity to contribute to Wisconsin's wildlife conservation movement, is proposed in the third publication of the state university's Science Inquiry. Members of the commission who prepared the report include: Professors Aldo Leopold, agricultural economics; L. J. Cole, genetics; N. C. Fassett, botany; C. A. Herrick, Chancey Juday and George Wagner, all of zoology.

The institute, through which cooperative relationships would be maintained with the state conservation department, with other state and federal bureaus, with the lay movement, with other educational institutions and especially with other departments of the state university able to contribute to conservation, would be composed of a series of four chairs to cover the wildlife field.

These would be those of game management, already established; fish management, floral conservation and ornithology and mammalogy. Each of the four divisions could be connected with a present department of the university.

The chair of game management, established by the Wisconsin Alumni Research Foundation in 1933, is now connected with the College of Agriculture. The chair of fish management, which would apply to aquatic conservation problems the great accumulation of research on Wisconsin waters collected during the past half-century by the Wisconsin Natural History Survey, would be attached to the department of zoology. The chair of floral conservation, designed to work out techniques for conserving non-commercial plants, would be attached to the department of botany, while the chair of ornithology and mammalogy, which would work out techniques for conserving non-game birds and mammals, would be attached to the department of zoology.

Each of the four chairs which would compose the Wildlife Conservation Institute would teach cultural courses to non-professional students, would do research with the help of graduate students aiming at professional careers, and would build up demonstration areas and other physical equipment for research and teaching.

The Wisconsin Science Inquiry, of which the wildlife conservation publication is the third, was established at the university in 1934. The objective of scientific studies made under the inquiry is to appraise the nature of a certain problem and its significance to the state, to examine the facilities available for its study at the university and to sketch the outlines of a more comprehensive attack upon the problem for the benefit of the state.

GIFT TO BROWN UNIVERSITY OF A CHEMICAL RESEARCH LABORATORY

A gift of $500,000 to Brown University to construct a new chemical research laboratory was announced on March 29 by President Henry M. Wriston. The gift is from Jesse H. Metcalf, formerly United States senator from Rhode Island, a member of the Board of Trustees.

The fund will be used to build and endow a laboratory for research in specialized phases of electrochemistry and photochemistry. The new building will more than double the present accommodations and equipment for research. A site for the laboratory will be chosen in the near future. Actual construction will begin as soon as plans can be approved and contracts let. The new laboratory is expected to be ready for occupancy by next spring.

Research in chemistry for the last seventy-five years has been conducted for the most part in the Newport Rogers Laboratory. The new building will contain research equipment for between thirty and forty graduate students and for the research staff, more than twice as many as can be accommodated now. It will have adequate library facilities. It will in future be possible to give undergraduates majoring in chemistry added opportunity to carry on chemical investigations of their own.

Mr. Metcalf's interest in the department has been

largely responsible for the expansion of its facilities in recent years. In 1922 he gave funds for the construction and endowment of the Jesse Metcalf Memorial Laboratory, named in memory of his father. At the same time he endowed a series of graduate fellowships and scholarships. His brother, the late Manton B. Metcalf of the class of 1884, also gave $100,000 for the endowment of the department of chemistry. With these gifts and the new facilities and financial support the department has developed into one of the strongest in the university. The opening of the Jesse Metcalf Memorial Laboratory in 1923 led to the introduction of a specialized undergraduate course of study leading to the degree of bachelor of science in chemistry, and to the expansion of the program of graduate work in the field of chemistry.

In a statement made by Professor Charles A. Kraus, research professor of chemistry, he said that the principal investigations to be carried on will be on problems in photochemistry, on the properties of electrolytes and dielectrics and on problems in organic and physical chemistry.

THE NEW BUILDING OF MELLON INSTITUTE

THE new building of Mellon Institute, the gift of Andrew W. and Richard B. Mellon, will be dedicated on May 6. It is outwardly classic in form, but within it contains laboratories and equipment of modern design. These new facilities will eliminate the overcrowded condition of the past and will increase the activities of the institute in both industrial research and research in pure science. The requirements of the institute made necessary a building of about six and one half million cubic feet. It is of limestone and granite.

Because of the massive exterior of the building, which has a rectangular row of sixty-two Ionic columns, it would have been impossible to place sufficient windows in the outside walls to provide adequate light for the numerous laboratories and offices. For this reason it was designed to include four interior courts as the main natural light sources. It is in the form of a hollow square, wider at the front than in the rear and with center and connecting wings in the form of a cross. The outside sections which surround the hollow square are nine stories high. The center wing, intersecting the square from front to rear, is of the same height. The cross wings, which connect the center wing with the east and west outside sections, are four stories high.

The fifth to eighth floors, inclusive, are devoted to laboratories for investigators on the staff of the institute. Each floor has special rooms for the use of all fellows, but most of the space is devoted to laboratories of two types—small laboratories for individual workers opening into the marble corridor, and larger laboratories arranged in suites, each with an office. The laboratories have exceptionally large windows and the courts on which they face are surfaced with glazed ivory terra cotta having high light reflectance.

The interior of the building is said by specialists to have the best arrangement and grouping of research laboratories possible. Back of the columns are abundant facilities intended to be both useful and convenient. There are in fact beauty and utility in all parts of the building and particularly in the library, the social room and the auditorium, which will make possible the holding of important scientific meetings at the institute. Automatic elevators, with massive but light aluminum doors opened and closed by photoelectric cells, connect conveniently all floors.

The same administrative procedure that is the day-by-day practice in the laboratories was applied to the construction and equipment of the new building. Test laboratories, for instance, were installed in a temporary building, and for two years details of equipment and arrangements were studied for possibilities of improvement. As a result, the wiring, piping and other systems were evolved, the wall brackets and removable cabinets designed and other details worked out. Piping is accessible, yet out of the way. Wall brackets are so built that shelves may be placed at will and instantly removed. Cabinets are constructed so that a complete unit may be removed and shifted to another laboratory when desired. Furniture is made without bolts or screws—only a rubber mallet is needed to take apart the laboratory tables or to add to them.

Among other special features are the constant-temperature, constant-humidity rooms, facilities for nutritional studies, a section of laboratories devoted to ceramic furnaces, ample room for the grouping of unit or experimental plants for basic production research in evolving chemical manufacturing processes, an analytical department, machine, instrument and glass-blowing shops and x-ray and spectroscopic facilities, all available for the use of fellows of the institute.

According to Dr. Edward R. Weidlein, director of the institute, more fundamental knowledge is to be sought through the expansion of the staff and facilities in those departments dealing with research in the pure sciences. The institute has maintained a department of research in pure chemistry since 1924 and has made important contributions to that science and to public health. It will now be able to devote attention to major problems in the fields of pure physics and biology. Industrial research for which it is best known will continue to be encouraged fully and will be benefited by the research in the pure sciences. At present sixty-five industrial fellowships are in operation.

SCIENTIFIC NOTES AND NEWS

AT the dinner on March 30 of the first International Congress on Fever Therapy, held in New York City, the French government, represented by Count Charles de Ferry de Fontnouvelle, French Consul General of New York, conferred membership in the Legion of Honor on four Americans who have been foremost in fever therapy experiments. They were: Dr. William Bierman, president of the American Congress of Physical Therapy and director of the department of physical therapy at Mount Sinai Hospital; Charles Franklin Kettering, vice-president of General Motors Corporation and director of its research laboratories; Dr. Walter Simpson, one of the pioneer workers in this country in the production of fever, and Dr. Willis Whitney, retired director of the General Electric Company's research laboratories. Dr. Simpson and Dr. Bierman were recognized for their experiments and research in artificial fever; Mr. Kettering and Dr. Whitney for discoveries and inventions that had helped to apply fever therapy in a practical manner.

THE Howard Crosby Warren Medal for outstanding research in experimental psychology has been awarded for 1937 to Professor Karl Spencer Lashley, of Harvard University, "for his distinguished work on the physiological basis of learning and on the neural mechanisms involved in vision." The award was made at the annual meeting of the Society of Experimental Psychologists, Inc., held at Smith College, Northampton, Mass., on March 25 and 26. The Warren Medal was established in 1936 through the generosity of Mrs. Warren in memory of her husband.

AT the annual general meeting of the Institution of Petroleum Technologists held on March 9, the Redwood Medal was presented to Mr. Harry Ricardo, in recognition of his contributions to the advancement of the science and technology of petroleum.

Nature reports that the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize for the period 1932–36 to Professor C. G. Darwin, master of Christ's College, Cambridge, formerly Tait professor of natural philosophy in the University of Edinburgh, "for his distinguished contributions in mathematical physics"; and the Makdougall-Brisbane Prize for the period 1934–36 to Dr. E. M. Anderson, formerly of H.M. Geological Survey (Scotland), for his paper "The Dynamics of the Formation of Conesheets, Ringdykes, and Caldron-subsidences," published in the society's *Proceedings* within the period of the award.

THE Senate of the National University of Ireland has voted to confer on Hugh O. Hencken, director of the Harvard archeological expedition to Ireland, curator of European archeology at the Peabody Museum at Harvard University, the honorary degree of Litt.D.

THE degree of doctor of science has been conferred by the University of Oxford on Dr. The. Svedberg, professor of physical chemistry at the University of Upsala.

DR. JULIUS WAGNER-JAUREGG, professor of psychiatry and neurology at Vienna, celebrated his eightieth birthday on March 7.

AT a meeting of the Royal College of Physicians, London, on March 22, Lord Dawson of Penn was reelected president.

OFFICERS of the Geological Society of London have been elected as follows: *President,* Professor O. T. Jones; *Vice-presidents,* Professor W. T. Gordon, J. F. N. Green, Professor W. J. Pugh and Professor H. H. Swinnerton; *Secretaries,* Dr. L. Hawkes and Professor W. B. R. King; *Foreign Secretary,* Sir Arthur Smith Woodward; *Treasurer,* F. N. Ashcroft.

DR. JOHN G. KIRKWOOD, of Cornell University, who received the 1936 award in pure chemistry given by the American Chemical Society, has been appointed associate professor of chemistry at the University of Chicago. Dr. George W. Wheland, now in England as a Guggenheim fellow, has been made instructor in the department of chemistry.

DR. E. G. ANDERSON, of the California Institute of Technology, has returned to Pasadena after spending the past three months at the University of Minnesota as guest professor, teaching advanced courses in plant genetics.

DR. PAUL H. FALL, since 1920 professor of chemistry and head of the department of chemistry at Hiram College, has been appointed associate professor of chemistry at Williams College.

DR. WAYNE DENNIS, of the University of Virginia, has been appointed visiting professor of psychology at Clark University for the academic year 1937–38. He will offer work in child psychology and social psychology. Dr. Robert H. Brown has been appointed assistant professor of psychology and philosophy, beginning with the opening of the same year.

DR. JAMES ARCHIBALD DOUGLAS, of Keble College, has been elected to the chair of geology at the University of Oxford.

PROFESSOR SAMUEL SUGDEN, of Birkbeck College, has been appointed to the university chair of chemistry tenable at University College, London.

DR. ARTHUR B. CLEAVES, who has been appointed junior geologist on the Pennsylvania Topographic and Geologic Survey, has been elected permanent secretary of the Field Conference of Pennsylvania Geologists, Harrisburg.

THE Lucius N. Littauer Foundation has awarded a grant to Dr. Israel S. Kleiner, professor of biochemistry at the New York Medical College, to aid in his studies of the male hormone.

DR. H. J. MULLER, formerly professor of genetics at the University of Texas, who has been working with N. I. Vavilov in Soviet Russia, reached Valencia on his way to Madrid on March 15 to join the Canadian blood transfusion unit. He expects later to resume his work in Moscow.

DR. EDWIN GRANT CONKLIN, emeritus professor of biology at Princeton University, lectured on "Biology and Social Problems" on April 2, 3 and 9 on the Richard B. Westbrook Free Lectureship Foundation of the Wagner Free Institute of Science, Philadelphia.

DR HAROLD C. UREY, professor of chemistry at Columbia University, delivered the lecture at the annual public meeting of the Harvard University Chapter of the Society of Sigma Xi on March 31. His subject was, "The Problem of the Concentration of Isotopes."

DR. C. N. H. LONG, professor of physiological chemistry at Yale University, will deliver the seventh Harvey Society Lecture of the current series at the New York Academy of Medicine on April 15 at 8:30 P. M. Dr. Long will speak on "The Influence of the Pituitary and Adrenal Glands upon Pancreatic Diabetes."

DR. CHESTER M. ALTER, of the department of chemistry of Boston University, lectured on March 22, 23 and 24 on "Radioactivity and the Determination of the Age of the Earth" before the faculty and students of science at Colby College, Bowdoin College and Bates College.

DR. WILLIAM HEALY, director of the Judge Baker Guidance Center, Boston, will deliver the fifth series of the Thomas William Salmon Memorial lectures at the New York Academy of Medicine on April 9, 16 and 23. The titles of the lectures are: "Foundations of the Personality Structure," "The Developing and Emerging Personality" and "Personality in Widening Human Relationships."

DR. ALEXANDER SILVERMAN, head of the department of chemistry in the University of Pittsburgh, delivered the inaugural Charlotte A. Bragg Memorial lecture in chemistry at Wellesley College on March 19. He spoke on "Glass and the Modern World."

THE scientific sessions of the American Heart Association will be held on June 7 and 8, from 9:30 A. M. to 5:30 P. M., in the Viking Room, Haddon Hall, Atlantic City, New Jersey. On Monday, June 7, the program of the Section for the Study of the Peripheral Circulation will be given. The general heart program will be presented on Tuesday, June 8.

THE second International Conference of History of the Americas will be held in Buenos Aires from July 5 to 10 of this year, under the joint auspices of the Argentine government and the Junta de Historia y Numismática Americana. It will have special sections devoted to the history of each of the countries of this hemisphere, for the discussion of topics such as the conquest and any aspects of their political, cultural, economic, military, naval and diplomatic history and numismatics. Societies, historians, professors and other persons interested in this field are invited to participate in the gathering. The president is Dr. Ricardo Levene, formerly president of the University of La Plata, and the secretary is Dr. Mariano Belgrano, Museo Mitre, San Martín 336, Buenos Aires, Argentina.

THE estate of the late Noyes D. Clark, of New York City and Bethany, except for specific bequests of $64,000, has been bequeathed to the Sheffield Scientific School of Yale University to set up a Dwight Noyes Clark and Noyes Dwight Clark scholarship fund, in memory of the donor and his father. The estate is estimated to be worth from $500,000 to $1,000,000.

THE California Institute of Technology has awarded contracts for four new buildings to be erected at a cost of more than $1,000,000. These include the second unit of the Kerckhoff biological laboratories; the Crellin laboratory of chemistry; the Seeley W. Mudd geology laboratory and Charles Arms geology laboratory. The new unit for biology is financed from a fund given by the late William G. Kerckhoff, of Los Angeles, and Mrs. Kerckhoff. The unit for chemistry is given by Mr. and Mrs. E. W. Crellin, of Pasadena. The third building is the gift of Mrs. Seeley W. Mudd, of Los Angeles, as a memorial to her late husband. The Charles Arms laboratory is given by Mr. and Mrs. Henry M. Robinson, of Pasadena, in memory of Mrs. Robinson's father, operator of mining properties. Mr. Robinson, a Southland banker, is vice-president of the board of trustees of the institute.

FOR the support of the Kansas State College, Manhattan, for the biennium beginning on July 1, the State Legislature has appropriated $2,511,000, including $450,000 for a new building to house the departments of chemistry and physics.

ANNOUNCEMENT of a Museum Building to be constructed at Mound Park, Moundville, Ala., has been

made by Dr. Walter B. Jones, state geologist in charge of excavations in the Moundville area. Plans for the structure call for a central building 130 feet by 43 feet, surrounded on all sides by terraces. The building itself is to consist of a central exhibition hall 40 feet by 60 feet in size, with a wing on each end of the exhibition hall to house burial pits already excavated. No change will be made in these burial pits, which were excavated and put in their present condition by Dr. Jones and his assistants. Remains of the Mound Culture and Mound Indians are preserved in these burial pits, which have been exposed and laid open to view. Construction of the museum is the joint project of the Civilian Conservation Corps and the National Park Service.

REORGANIZATION of the Biological Board of Canada under the name of "The Fisheries Research Board" is provided in a bill introduced in the House of Commons, Ottawa, by Hon. J. E. Michaud, Minister of Fisheries. Mr. Michaud said that the old name was misleading to the public, as the work of the organization was confined to fisheries, and did not extend to biology generally. Some universities did little or no work on fishery research and they would not be represented on the new board. It will consist of fifteen members appointed by the Minister, two from the Department of Fisheries, two representing the Atlantic Coast and two the Pacific Coast fishing industry, and nine scientific men selected from a list which will include nominations by any Canadian university whose staff includes investigators engaged in research bearing on fishery problems.

THE Association of American Medical Colleges has completed the study of the accomplishment of all freshmen in medical schools during the session 1935–1936. Any arts college or university which would like to have a report on those of their students whose records form a part of this study may obtain it by writing to the secretary of the association, 5 South Wabash Avenue, Chicago, Illinois. This study has been made each year since 1928. The records of students in the second, third and fourth year of the medical course may also be obtained if the names of such students are given. The full four-years report applies only to the class which entered medical school in 1932; the first three years for the entrants of 1933; first and second year for the entrants of 1934; freshmen for 1935.

THE *Journal* of the American Medical Association reports that it is hoped to finish the building of the Paris Eastman Dental Clinic in time to hold the dedication ceremonies on July 4, 1937. The president of the French Republic, M. Lebrun, Ambassador William C. Bullitt and a number of other leading French and American personalities will be invited to take part in the ceremonies. The clinic is designed to provide free dental service for children less than sixteen years of age who are unable to pay. It occupies a large area, and the land surrounding the clinic will be converted into parks and playgrounds. The work of the Paris Eastman Dental Clinic will be based on that carried out at Rochester, N. Y., and it should serve as a center for dentists and dental surgeons to carry on research and postgraduate work. It will also aim to teach children and parents the need and value of regular dental work.

THE transfer of the *Discovery* to the Boy Scouts' Association is reported in the London *Times* to have considerably disorganized the arrangements of the British Antarctic Expedition Committee and has made it impossible for them to carry out their original program. E. W. Walker, commander of the proposed Antarctic expedition, states that a certain proportion of financial support was conditional on acquiring the *Discovery* and will no doubt be withdrawn. It is the intention to readjust the organization and draw up a new program.

DISCUSSION

MIMICRY, AS VIEWED BY PROFESSOR SHULL

THE book on "Evolution," by Professor A. Franklin Shull, is, according to the preface, an "attempt to review the field of evolution as it appears to modern biologists, with the genetic bearings indicated wherever these may reasonably be assumed." It is stated that "general books on evolution have . . . lacked any adequate application of knowledge of genetics to the problems of evolution."

One of these problems is natural selection, and the author discusses it with special reference to the theories of mimicry and other forms of protective coloration. Now the field of genetics is scarcely the standpoint from which to survey problems of the coloration of insects as a whole, for genetics are primarily concerned with the basic changes which result in *production* of a certain appearance, whereas the problem for the mimetist is not "how or why" a habit or pattern is produced, but how or why it *survives*. There is thus from the beginning a discrepancy which is constantly apparent between Professor Shull's point of view and

the phenomena which he discusses. The question whether various types of coloration really are of use is treated from a philosophical point of view rather than from that of a naturalist in the field who sees events happening.

The study of mimicry suffers much because it is so often discussed by critics as an isolated, rather peculiar, rare phenomenon exemplified by a few butterflies and moths and made of too much importance by a band of imaginative enthusiasts. Few critics seem to be aware of the great extent of the phenomenon, and Professor Shull is no exception. Thus, page 181 seems either to expose his unfamiliarity with the subject or to be an unworthy attempt to pour scorn upon it. What is to be thought of the statement that the bulk of instances of mimicry are among the butterflies and moths or of allusions to "the alleged mimicking of the lady beetle by other beetles, of a beetle by a grasshopper, of a wasp by a beetle . . ." and so on? "Most instances of mimicry in butterflies occur in a certain small group of subfamilies." This is most misleading in seeming to suggest affinity as the cause of mimicry—a suggestion which can not be sustained for the phenomena as a whole.

Mimicry is of the same order as the procryptic resemblance of a Membracid to a thorn: an insect escapes being eaten because it reminds the enemy of an object which he is not accustomed to eat, either because it is unpleasant or because it is of no food value. Affinity does not account for the resemblance of a caterpillar to a twig or a bird-dropping, neither does it explain the superficial resemblance of a fly to a wasp.

Mimicry is embraced by the sentence (p. 167), "the animals are presumably seen but are regarded as of no interest by prospective predators," which the professor applies to procryptic species. Carrick[1] showed that a bird taking food to its young did not perceive stick-caterpillars at rest on twigs at the entrance to its nest, but if these were placed where they were obvious they were picked up and given to the young.

The fundamental principle of *relative* edibility is ignored in such a phrase as "unfit to eat" in an argument on page 177, though the author invokes it for his own purpose on page 172. Edibility depends upon the presence together of a number of articles of food having different qualities of taste. Under pressure of starvation men have been known to devour boots; the present writer has seen a wren in a wood in winter extract from dead leaves and devour a large cock-tail beetle, black and stinking, possessed of all the attributes of a defensively colored species. On the other hand, in his experiments with two young monkeys[2] the writer found that the soft-bodied, brightly colored Lycid beetles were placed by them as near to absolute inedibility as could be expected without real starvation. These beetles, wherever they occur, are mimicked by species of other orders; according to Morton Jones[3] a species was found to be equally unattractive to birds.

Referring to ants, Professor Shull enlarges on the danger of mimicking insects so much devoured by predators. But not by *all* predators! The monkeys mentioned certainly objected to ants running near them and pawed them away vigorously. The writer watched, in an African verandah, a wagtail picking up disabled flies which had been hit by a fly-flapper and, lying on the ground, attracted ants. The bird did not want to eat ants and shook vigorously the corpse of a fly, endeavoring to dislodge the ants which clung to it. If mere number were the chief factor in providing prey the bird could have obtained a greater weight of food had it attended to the ants instead of the less numerous fly corpses.

Another point made by Professor Shull is that protective coloration would not deceive insect enemies (p. 169). The force of this argument is weakened by the fact that nowadays no one supposes that it does: mimicry or procrypsis are not generally supposed to protect against predatory insects. It is true that in the days of teleological theology the resemblance of the fly *Volucella* to the bumble-bee in whose nest it breeds was claimed as a provision of Providence, whereby the fly can enter the nest unharmed, but such views are not in accord with the present day.

The subject of warning colors is lightly treated, and finally (p. 212) contemptuously dismissed, but students of living insects in their natural environment will not agree with this. It is difficult to believe that Professor Shull has any acquaintance with the working of this principle; it is a phenomenon of life and not of museum specimens or logical arguments. What meaning can there be in the following occurrence, unless warning colors *are* accepted as such by predators?

The writer experimented on two young monkeys with miscellaneous insects.[4] A large grasshopper, shiny blue-green and red, which freely exposes itself in the open, was put down for a monkey to see. "It at once erected its wings vertically, showing their purplish-red and black colour, but made no attempt to escape." The monkey "looked very hard at it, took hold of one wing, let go, and again looked very hard at it, but made no attempt to eat it." But he immediately devoured a large procryptic grasshopper put down in the same way, and then another. More con-

[1] R. Carrick, *Trans. Royal Ent. Soc. Lond.*, 85: 131–139, pls. 1–3, 1936.

[2] G. D. Hale Carpenter, *Trans. Ent. Soc. Lond.*, 1921: 1–105, 1921.

[3] F. Morton Jones, *Trans. Ent. Soc. Lond.*, 80: 345–386, pls. 18–28, 1932.

[4] *Loc. cit.*

vincing still was his behavior in the bush under close observation, but free to do as he liked. He found a pair of these warningly colored grasshopper *in copula,* freely exposed on short grass, a fact in itself highly suggestive. He "went up to them and pawed the male. Without attempting to get away, the grasshopper merely erected its wings perpendicularly so as to display their purplish and black colors. The monkey took no more notice and ate some grass. Afterwards he ate other insects, including a large *Cyrtacanthacris* grasshopper." The same maneuver was utilized by another member of this species when threatened by a fowl which ran up to it, halted, gazed at it and walked away. The specimen was then killed, and laid on the ground with its purple wings hidden under the covers; fowls were seen to peck at it but obviously found it very tough and, though they pulled it about, ate none of it. Professor Shull comments on the danger of drawing conclusions from experiments on animal behavior (p. 183), but quotes experiments to show that birds may not see colors as we see them, for "some experiments by Hess on domestic fowls indicate that the middle to red portions of the spectrum are more easily seen than the blue and extreme red."

The inner significance of this is, however, not noted by the critic: it is that, broadly speaking, red, orange and yellow are the very colors utilized for warning, while blue and green are rare in comparison.

"Logical Objections" to natural selection take no account of the facts that the possession of stings, poison spines or irritating hairs, emission of acrid juices or foul odors, toughness and powers of resistance, even to chemical injury, are associated with characteristics of the living animal such as instincts leading it freely and fearlessly to expose itself, often herded in masses whereby conspicuousness is increased, together with slow and heavy gait or flight, the latter sometimes accompanied by a loud rattling noise. Why is such an association not found among insects that resemble their surroundings when it is characteristic of those that have warning colors? And why almost entirely among insects of *diurnal* activity if the colors are not meant to be seen; and if they *are* meant to be seen what other explanation than natural selection fits all the facts?

Professor Shull does not seem to have grasped the principle of common warning colors, for he finds it difficult to imagine how a species can derive advantage by changing from one warning color to another (p. 189). If two species, A and B, each have a pattern which has to be learned by enemies, the loss resulting to each species, *and each pattern,* will be a certain percentage, let us say 10 per cent. But if two species combine to show a single pattern, the loss to the pattern remaining as before at 10 per cent., the loss to the two species bearing that pattern will be 10 per cent *divided between them,* or between as many more as through the processes of variation, have been able to enter into that pattern.

The fundamental principle of mimicry, that it is the artist and not the anatomist who is deceived, has a bearing on one of the most important attributes of natural selection, the production of a result by different means. Professor Shull treats this very lightly and reduces it to genetics (p. 184). But an argument based on corresponding mutations fails to explain cases such as that of two Longicorn beetles in Australia which resemble a wasp. The latter bears the characteristic Australian aposeme of red-brown and black in transverse bands. One beetle reproduces the effect on its elytra, the other has the elytra so aborted that such a display is impossible: the colors, however, are shown to the same extent as in the other species, but across the exposed dorsal surface of the abdomen concealed in the first beetle. The effect is the same to the eye at a little distance.

Two especially striking illustrations of the principle are given by Poulton,[5] but lack of space forbids further treatment of it here. The argument based on corresponding mutations can not stand for mimicry as a whole, nor for its analogue, procryptic resemblance. Would Professor Shull apply it to the resemblance of a moth to a bird-dropping? Even for mimicry between butterflies it has been shown to be invalid.[6]

Professor Shull adduces among his "logical objections" the extremely feeble one, "those few instances in which model and mimic do not occupy the same area" (p. 188). Has he any idea at all of the disparity between the great numbers of cases in which the correspondence in distribution is close and the comparatively few cases in which there is little or no correspondence and for which it may be said, there is a possible explanation which demands further knowledge of the movements of migrating predators? Cases which must be ascribed to pure coincidence do exist, and Dixey[7] carefully examined the question. His paper reveals the weakness of the argument based on coincidence. The fact that Handlirsch is quoted in favor of this argument (p. 192) only suggests that that expert morphologist knew no more than Professor Shull of the correlation in distribution which has been worked out for such African species as *Papilio dardanus, Pseudacraea eurytus, Acraea johnstoni,* for the American *Limenitis* or the Euploeas of Fiji.

Finally, space allows no further criticism than to

[5] E. B. Poulton, *Trans. Ent. Soc. Lond.,* 79: 395–398, pls. 14–15, 1931.

[6] E. B. Ford, "Mimicry" (Methuen's Monographs) by Carpenter and Ford. Pp. 106–7, 1933.

[7] F. A. Dixey, *Proc. Ent. Soc. Lond.,* 1913: 60–69, 1914.

oint out that, in this book, mimicry is regarded as a ere question of "similar patterns" (pp. 181, 192). n page 193 we find that color may be "purely incintal" and the suggestion is made that spots occur a certain place "because in that position the physiogical gradient decrees the appropriate mutation." he extremely narrow view of mimicry which prompts ch argument ignores the fact that mimicry is not erely a question of color and pattern but of shape, stincts and habits.

Moreover, such an argument takes no account of the esemblance of a moth, beetle or caterpillar to a birdropping, of a spider to an ant or of a young grassopper in which resemblance to an ant is produced by e artistic process of painting out by pale pigment a rge part of the corpulent abdomen, so that the narow "waist" of the ant is pictured by a thin strip of e normal dark color, the remainder of the robust ody being rendered invisible in its natural surroundgs.

The writer concludes with commending to all stuents and critics of mimicry the slogan, "Mimicry eceives the artist but not the anatomist."

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A SYSTEM FOR FILING MONOGRAPHS, PAMPHLETS AND REPRINTS

SEVERAL systems for filing pamphlets and reprints ave been suggested (Stone[1]; Storer[2]; Eikenberry[3]; Iorrey[4]; Harper[5]; Miller[6]; Montgomery[7]; Boring[8] nd Smith[9]). Each of these systems embodies certain seful and helpful suggestions. The following plan as been used by me for several years and it has been ound to be very efficient. Since many of my friends ave commented favorably on the system, I am preenting a brief outline of it so that others may adopt t or certain parts of it.

As monographs, pamphlets and reprints are reeived, they are classified according to their subjects. f more than one subject is included in a single reprint, s is often the case, then an effort is made to select he subject-division which seems to be the best one uited for my collection. As soon as the reprints are lassified according to subjects, a white gum label, 1½ y 15/16 inches, is placed on the upper left-hand corer of the front cover of each reprint or, if the reprint oes not have a cover, the label is placed on the corresponding position of the front page. The subject-division of the classification, the number of the reprint in that division and the total series number are all written in that order on the label. For example, the 117th reprint on "Blood" was the 869th paper classified, and the 620th paper on "Endocrines" was the 1880th paper classified. The notations on the labels for these two reprints appear as follows:

Blood	Endocrines
#117	#620
No. 869	No. 1880

If a series of two or more reprints are bound under one cover by the publishers, as is sometimes the case for economic reasons, then the label carries as many numbers as there are separate papers bound together. The label is used so that the notations may be easily read, and this is a definite advantage, since many covers are colored. Also the label serves as an identification tag if one loans his reprints to other individuals.

A card catalogue is arranged according to both authors and subjects for all the classified reprints, and regular 3×5 cards are used. If there is only one author's name appearing on a reprint, then it is necessary to make two cards. On one of these the author's name appears first, and it is followed by the title and reference in that order. On the other card, the title appears first, and it is followed by the name of the author and the reference. If there are two authors' names appearing on the reprint, then it is necessary to make three cards: one where the subject appears first, and then each author's name appears first on individual cards. If there are two or more author's names, they are arranged so that each one heads the list. The notations on the label on a reprint are typed in the upper right corner of both the author's and the title cards. The author's cards are arranged alphabetically and kept in a filing cabinet. The subject or title cards are filed in the same order as the reprints appear in a division, and in the same order that the divisions appear in the classified systems, and therefore the title cards for a particular division are kept together in the files. This is particularly handy for surveying the various titles in a division, since it is more convenient to remove several hundred cards to one's desk than it is to remove a corresponding number of reprints. Also, this method tends to preserve the reprints, since they are handled only when they are needed.

As soon as the index cards have been prepared, the separate reprints are filed in drawers with their front covers forward and their backs uppermost. This makes it easy to read the notations on the labels.

If a reprint does not fall into one of my divisions,

[1] Witmer Stone, SCIENCE, 22: 53, 1905.
[2] Tracy I. Storer, SCIENCE, 44: 735–739, 1916.
[3] W. L. Eikenberry, SCIENCE, 45: 64–65, 1917.
[4] Chas. B. Morrey, SCIENCE, 45: 87, 1917.
[5] R. M. Harper, SCIENCE, 45: 315–318, 1917.
[6] M. R. Miller, SCIENCE, 46: 263–264, 1917.
[7] Priscilla B. Montgomery, SCIENCE, 52: 583, 1920.
[8] Edwin G. Boring, SCIENCE, 58: 329–330, 1923.
[9] Erwin F. Smith, SCIENCE, 58: 396–397, 1923.

it is placed in the general file, which is indexed according to the author's name or to the name of the first author, in case there are two or more authors. These filing cards also carry the titles and the references and are filed alphabetically according to the author. The author cards are adequate information for one to determine whether he has received a particular reprint. The reprints in the general file are neither given a number nor labeled. However, as soon as several reprints on some subject accumulate in the general files, they are removed and they constitute a new division. The cards in the general files are removed and the new division, number of the reprint in the division and the number in the series are typed in the upper right corner. A title card is made, and if more than one author's name appears on the reprint, cards are made for each of them as described above.

The advantage of having an author's card made for each reprint that is classified is evident for at least two reasons: first, one has all an individual's references filed together and, second, it saves time in determining whether one possesses any of an individual's reprints and if so, which ones. The cross references might not be so essential if a group of individuals should become associated for life and publish all their researches as from one institution, but since a majority of individuals become connected with two or more institutions during their active careers, it is expedient that each author be given an entry for each paper that bears his name.

If a reprint were dated when it arrived, it would often lead to confusion. The chief reason for not doing so is that one often receives reprints from co-authors after one of them has accepted a position elsewhere. If they had published a series of papers, one might receive the last few numbers of the series from one of the authors, and then some months or years later one might receive some of the earlier numbers from the other author. If one had dated the first papers when they arrived, it would be difficult and confusing to explain why the older papers arrived last.

Reprints from several authors that have been bound and sent to me from some individual or institution are not included in either the classified reprint or the general files, but are given space on the shelves with the bound books. However, if reprints of a symposium are bound together, they are filed according to the division they fall into. Such a volume is given as many numbers as it contains individual articles. That is, if a volume of a symposium contains twelve papers, then the numbers on the label would so indicate.

With this system of indexing and filing, it is as easy to locate a reprint, if you know the author or authors, as it is to locate a book on a regular library shelf. At the present time, I have about 4,000 reprints classified and about 1,500 more in the general files. The classified reprints are filed in steel and wooden drawers, while the general reprints are filed in boxes.

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STARS IN THE BIOGRAPHICAL DIRECTORY OF AMERICAN MEN OF SCIENCE

IN view of the publication of a sixth edition of the "Biographical Directory of American Men of Science" I feel impelled to make some remarks about the affixing of stars to certain of the names. The selection of such names is made on a basis that is not very clear to me, and I doubt that it is well defined in the mind of the editor himself. The latter uses such designations as "leading scientific men," "most eminent men," "first—among research workers."

Now I must confess that I regard these elections to stardom as a somewhat childish albeit amusing pastime, but I understand that in some institutions the possession or lack of a star is taken very seriously and may even be decisive in questions of appointment and promotion. In view of that fact I would like to urge that the criterion on which selection is made be given a clearer definition. It should be pointed out that a "leading scientific man" is not necessarily synonymous with a "leader in scientific research." A biologist may be renowned as a writer of text-books and yet have a very poor record in the field of original research. He may be indefatigable and able in the administrative activities of scientific societies and still have only the most superficial interest in scientific discovery. But if eminence may rest on any one of such widely different endeavors it is only fair that that fact be definitely understood. Certainly the editor should make it clear that at present these eminent scientists are not necessarily outstanding research workers.

Personally I would much prefer to see the custom of starring abandoned altogether. I seriously question the justification for printing the results of such an election in a volume which is nothing more nor less than a directory.

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THE PERCENTAGE OF IRON IN HEMOGLOBIN

IT is known that the percentage of iron in different mammalian hemoglobins is substantially the same. In attempting to look up this rather fundamental value for use in teaching, we found the value 0.0335 given in Hawk and Bergeim's "Practical Physiological Chemistry" (10th ed., p. 467), in Starling's "Human Physiology" (7th ed., p. 652), in Bodansky's "Introduction to Physiological Chemistry" (3rd ed., p. 234),

and in Robertson's "Principles of Biochemistry" (2nd ed., p. 390). Reference to the original analyses[1] makes it clear that the above value has an extra zero inserted after the decimal point and that the correct value is about 0.34. The decimal point is correctly placed in the values given in Harrow and Sherwin's "Textbook of Biochemistry" (p. 492), Mathews' "Principles of Biochemistry" (p. 351), Mattice's "Chemical Procedures for Clinical Laboratories" (p. 138), Macleod's "Physiology in Modern Medicine" (7th ed., p. 86), and McClendon and Pettibone's "Physiological Chemistry" (6th ed., p. 143).

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REPORTS

RESEARCH IN THE FIELDS OF GEOLOGY, CHEMISTRY AND PHYSICS

In the spring of 1936 two steps were taken by the National Research Council to ascertain what researches were regarded as especially important and timely in the fields of geology and geography and in the borderlands between geology and chemistry and physics. The first step was to send a letter of inquiry from Dr. E. S. Bastin, chairman of the Division of Geology and Geography, to about 300 prominent geologists and geographers. Those replies that related largely to the recognized confines of geology and geography have been edited and issued in mimeographed form by the National Research Council.

The second step consisted in the establishment of an interdivisional committee, comprising geologists, physicists and chemists, to consider the borderland problems between these sciences. This committee was under the chairmanship of Dr. Thomas S. Lovering. Its purpose was not only to review and appraise the borderland problems but also to suggest modes of attack and the possibility of applying special techniques familiar to physicists or chemists that might prove useful in the solution of certain geologic problems. Much of the work of this committee has been accomplished, and the list of the research problems that it has considered will be published at an early date.

It seems highly desirable when problems requiring a new and difficult technique are started for the investigator to have available information as to where the work in which he is interested can best be carried on and where he may consult with men who have had experience with some of his special problems. It thus seems desirable that the final report include the names of those organizations that have special facilities for or experience with certain types of research problems whose solution requires equipment not commonly available. The committee realizes that it is unable to prepare an adequate list without the full cooperation of the many scientists working in the borderland fields. It is our earnest desire that all individuals, especially chairmen of departments of geology and mineralogy, who know of such special facilities for research of the type listed below, will make them known to some member of the Committee on Borderland Fields of Research before May 15. In the final report, which will be issued as a bulletin of the National Research Council, this committee will publish a list of the problems that have come to its attention and briefly consider the special types of techniques or equipment that can be applied to them, together with a list of those organizations having special facilities or experience with the individual problems.

The committee will confine its activity to the preparation of this report and does not contemplate participation in plans for financing any of the researches suggested. It is hoped that the final report will stimulate research in the borderland fields by some chemists and physicists as well as by geologists. It must be realized by geologists, however, that the brunt of the work has to be borne by them and that the chief contribution which they should expect from physics and chemistry is one of methods or techniques.

The types of research in borderland fields of physics, chemistry and geology, requiring special facilities are listed below:

(1) *Phase equilibria study:*

- Equilibria in anhydrous melts at high temperatures.
- Equilibria in systems containing volatiles at moderately high temperatures and pressures.
- Equilibria in saline solutions at room temperatures.
- Equilibria of sulfides in contact with volatiles such as water and chlorine over a range of temperatures and pressures.
- The alteration of rocks and minerals by hydrothermal solutions over a range of temperatures and pressures.

(2) *Analyses:*

- A control laboratory for the identification and analysis of minerals by x-ray and spectroscopic methods is greatly needed. The services of the laboratory should be available to all and at a minimum cost.

[1] O. Zinoffsky, *Zeitschr. f. physiol. Chem.*, 10: 16, 1886; A. Jaquet, *ibid.*, 14: 289, 1890; G. Hüfner, *Arch. f. Physiol.*, 130, 1894.

(3) *Colloids:*

The deposition of minerals as colloids and their subsequent crystallization, special attention being given to the sulfides. The studies should be carried on over a range of temperatures and pressures.

The effect of coagulation on size distribution of clay particles.

(4) *The physical chemistry of replacement at moderately high temperatures and pressures:*

Replacement in the geologic sense means the dissolving of one mineral or a group of minerals and the immediate deposition of another mineral or group in the place thus vacated, with no intervening formation of open spaces. An explanation of the physical chemistry of the large-scale replacement of essentially solid rock makes experimental work in the artificial production of replacements under closely controlled conditions of temperature and pressure highly desirable.

(5) *Radioactivity:*

The determination of the radioactive content of rock masses.

The determination of the helium content of rocks.

(6) *Differential pressures:*

The study of the physical and chemical conditions of formation of the "stress minerals," their stability fields and their orientation during crystallization. This research will involve investigation at temperatures ranging up to four hundred degrees Centigrade under differential pressures of many hundreds of atmospheres.

(7) *Determination of physical constants of geologic material:*

Determination of density, viscosity, porosity and the thermal and elastic constants of rocks and minerals in the laboratory.

The determination of as many physical properties as possible of rocks *in situ*, to be correlated with the constants determined by laboratory work on material typical of that studied in the field.

The change in physical constants with changes in temperature and pressure.

(8) *Rock deformation:*

Experimentation with scaled models that are dimensionally correct and the application of photoelastic techniques to the study of changes induced by stress.

(9) *Hydrodynamics:*

The principles of stream and wind action as ascertained by means of hydraulic laboratories and wind tunnels.

Investigation of the terminal settling velocities of masses ranging from small to large size.

The laws governing the orientation of unequidimensional particles under conditions of viscous, turbulent and plastic flow.

Rock permeability under special conditions, such as incomplete saturation, high pressure and high temperature.

(10) *Geophysics:*

Gravity instruments to determine gravity or gradient of gravity on land or on sea.

Seismic equipment for the investigation of general geologic problems, such as the extent of thrust faults and their change of attitude with depth, and the position and configuration of the floors of batholiths, and the structure of the continental shelfs and ocean bottom.

Tiltmeters to determine the body tides of the earth.

Magnetic equipment for investigation of geologic field problems or for investigation of magnetic properties of rocks and minerals.

Committee on Borderland Problems of Geology, Chemistry and Physics.

CHEMISTRY

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GEORGE W. MOREY
HOBART H. WILLARD

GEOLOGY

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R. A. DALY
C. N. FENNER
BENO GUTENBERG
M. KING HUBBERT
T. S. LOVERING, *chairman*
W. W. RUBEY

PHYSICISTS

HENRY A. BARTON, *ex-officio* (vice-chairman, division of physical sciences)
FRANCIS BIRCH
I. S. BOWEN
C. C. MURDOCK

SPECIAL ARTICLES

MAGNETIC ANOMALIES NEAR WILMINGTON, N. C.

A RECENT paper by one of us presented the results of a reconnaissance survey of the magnetic anomalies of a portion of the North and South Carolina Coastal Plain.[1] Since the publication of this paper the survey

[1] Gerald R. MacCarthy, *Jour. of Geol.*, 44: pp. 396–406, 1936.

been extended to include the region immediately t, north and northwest of Wilmington, N. C. As investigation has halted temporarily, it seems adable to present a brief report on our most recent rk.

An Askania vertical field balance, Schmidt type, was d throughout the investigations. Observations, ally at half-mile intervals, were made along all the in and many of the minor highways. In towns servations were spaced as closely as possible; in alities where strong magnetic anomalies were deted they were taken at intervals of one-tenth mile. though the swampy and often almost impenetrable ture of the intervening country precluded the rung of transverses between highways, a fairly close twork of highway traverses has been completed.

The magnetically disturbed area near Wilmington a small portion of a zone of disturbance which is ughly parallel with the trend of the present coaste. The full extent of this zone is not known beuse our work has been confined to the region between ntral South Carolina and the area immediately rtheast of Wilmington. The trend of this zone is ughly parallel with not only the coastline, but with e general regional trend of the Appalachian strucres which are exposed farther to the northwest. It s been suggested that the magnetic disturbances are flections of Appalachian type structures which are ried beneath the sediments of the Coastal Plain.[2]

The accompanying isogamic, or magnetic contour, ap is based upon about 550 observations. The trend

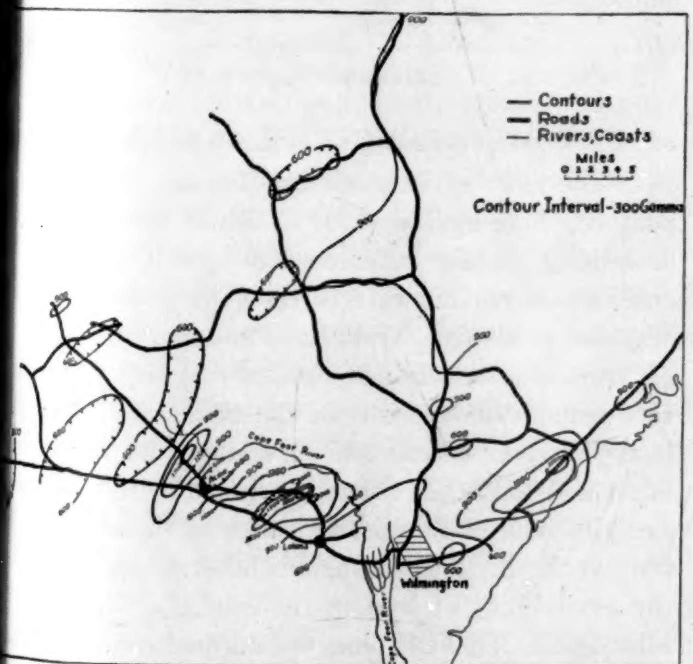

FIG. 1

f the magnetic structures outlined by these isogams roughly northeast-southwest, coinciding with the rend of the disturbed zone of which they are a part. Most of the magnetic structures are elongated oval highs and lows, the major axes of which are approximately parallel with the general structural trends of the region. The group of distinctly linear and closely spaced highs and lows about twelve miles west of Wilmington is most striking. The maximum anomaly in this particular area is about 1,700 gammas above the regional average. A larger, but less intensely disturbed, area where the coastal highway (U. S. No. 17) follows the crest of a magnetic high for several miles, has been found about ten miles northeast of Wilmington.

The individual highs and lows vary from narrow crests and troughs to broad ovals, with the magnetic gradient steeper along the shorter than along the longer axis, and also steeper toward the northwest than toward the southeast. These facts suggest that the geologic structures responsible for the anomalies dip toward the southeast.

Unfortunately, the country just north and west of Wilmington, through which the axis of the "Wilmington Anticline"[3] should pass, is largely an almost impenetrable swamp. Evidence for or against the existence of this uplift might be expected in this area, but because of the nature of the country, observations have not been made there.

The region here discussed lies within that in which the "Carolina Bays"[4, 5, 6] are found, rendering problems of interpretation somewhat complicated. However, all the non-linear or "point" highs so far discovered in connection with these bays are elongated in a northwest-southeast or a north-south direction, whereas all the highs shown on the accompanying map have a northeast-southwest elongation. The remains of a large iron meteorite might produce a marked magnetic high, but magnetic lows—such as the one that crosses the Acme-Leland highway about five miles northwest of the town of Acme—can not have such an origin. Our present interpretation of the anomalies shown on the map is that they are the reflection of structure and perhaps of topography in the pre-Cretaceous rocks which are buried beneath the sediments of the Coastline Plain. The larger anomalies, such as the one northwest of Acme, are much greater than those usually found in regions of unconsolidated sediments and could be produced only by the presence of large masses of iron-rich material.

The anomalies of this region are not only of scientific, but of practical interest. Noticeable compass

[2] *Ibid.*, p. 405.

[3] The phrase "Wilmington Anticline" as here used refers to an anticlinal structure that has been suggested by L. W. Stevenson. See his paper in *Jour. Wash. Acad. Sci.*, 16: 260–480, 1926.

[4] F. A. Melton and W. Schriever, *Jour. of Geol.*, 41: pp. 52–56, 1933.

[5] W. F. Prouty, *Jour. of Geol.*, 43: pp. 200–207, 1935.

[6] G. R. MacCarthy, *Proc. Geol. Soc. Amer.*, for 1935, pp. 90–91, 1936.

deflections have been observed in this area and, judging by the observed effects associated with equally intense anomalies elsewhere, local interference with radio reception might be expected.

Financial assistance for the field work was received through a grant-in-aid from the American Association for the Advancement of Science.

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EFFECT OF CERTAIN ENZYMES AND AMINO-ACIDS ON CROWN GALL TISSUES

THE relation of the crown gall of plants (caused by *Phytomonas tumefaciens*) to malignant tumors of animals is deservedly occupying the minds of pathologists. The status of this subject is excellently presented in a recent paper by Riker and Berge.[1] It is apparent that while the main trend of experimental work is toward determining the stimulatory factors in both crown gall and cancers, comparatively little has been done on the therapy of crown gall with the idea of the ultimate application of the results to cancers of animals. Crown gall and different types of sarcomas have been successfully treated by different forms of radiant energy.[2, 3, 4, 5] There seems to be a certain degree of similarity in response of plant and animal cancerous tissues to different types of physical treatment.

The author working with the crown gall on geranium (*Pelargonium zonale*) observed destruction of galls following injection of a mixture of *Erwinia carotovora* (the cause of a soft rot in carrots and other fleshy roots) strains into galls one month old. Gall tissue usually was completely broken down in from four days to a week, depending on the size of gall and environmental conditions. Galls on young tomato (*Lycopersicon esculentum*) and sunflower (*Helianthus annus*) plants were treated similarly and responded in very much the same way. After the destruction of gall tissue on geranium plants there was no new gall observed to appear after one year. Plants were always maintained in a good growing condition. Geranium plants inoculated with *E. carotovora* were never affected by the organism.

This interesting phenomenon led to the supposi that enzymes or other specific compounds might involved in the elimination of over-growth. With t thought in mind, the author tested diastase, papa pepsin, cysteine hydrochloride, leucine, iso-leuci tyrosine and tryptophane.[6] Cysteine hydrochlor was applied in view of the fact that this material w successfully employed in curing Jensen's sarcoma white rats.[7] All preparations tested were used in t form of 0.1 per cent. water solution or as cryst Galls employed for treatment were from one to t months old and ranged in size from 3 to 5 cms diameter and were induced on geranium and sunflo by a rose strain of *P. tumefaciens*. Injection of ma rials was made by hypodermic syringe in the case the water solutions. Dry powder (a few crystals each case) was introduced into a very small incisi made in the center of the gall. Sometimes the g treated with crystals were afterward atomized w sterile distilled water to aid the diffusion of the ma rial. Controls were represented either by injection sterile distilled water into the galls or by incisions w a sterile scalpel. In all treated cases, except w tryptophane and tyrosine, the galls gradually c lapsed, dried and remained on the plant as ha vestiges easily detachable. Pepsin and papain act very promptly, while diastase and other compou used mummified the galls of 3 to 4 cms in diameter from ten days to two weeks. In all these tests th were used from 10 to 20 galls for each treatme making a total of 180 galls with correspondi controls.

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SEX DIFFERENCES IN ANEMIC RATS

IN the issue of SCIENCE for January 29, 1937, a peared a note by Margaret C. Smith and Louise O describing certain differences observed between ma and female anemic rats in their response to vario remedial measures. With those supplements incapab of promoting a maximal rate of recovery, the fema rats responded better than the male rats. This w interpreted as a true sex difference, and the autho expressed the belief "that ignorance of this fact m explain some of the discrepancies of the same magn tude in the findings in various laboratories relative the availability of iron in foodstuffs." Also, in 19 Miss Helen Mitchell[1] observed an analogous phenom

1 A. J. Riker and T. O. Berge, *Amer. Jour. Cancer*, 25: 310–357, 1935.

2 C. Arnaudi and G. Venturelli, *Rivista di Biologia*, 16: 61–80, 1934.

3 Georges Lakhovsky, "L'origine de la vie," 175 pp. Gauthier-Villard et Cie. Paris, 1925.

4 I. Levin and M. Levine, *Jour. Cancer Research*, 7: 163–170, 1922.

5 J. W. Schereschewsky and H. B. Andervont. Publ. Health Report 43: 927–945, 1928.

6 Chemicals used were of the following brands: Papa Merck. Diastase, pepsin, leucine and tyrosine-Pfanstie One lot of pepsin from Parke, Davis and Co. Cyste hydrochloride, isoleucine and tryptophane—Eastman K dak Co.

7 C. L. Connor, J. L. Carr and L. Ginzton, *Proc. S Exp. Biol. and Med.*, 34: 374–376, 1936.

1 *Amer. Jour. Physiol.*, 101: 503, 1932.

in the rates with which young male and female develop anemia on a whole milk diet, from which concluded "either that the female is endowed with tter prenatal storage of iron or that she uses the which is available from endogenous or exogenous rces more efficiently than does the male."

hile it is true that male and female rats seem to used indiscriminately in investigations concerned nutritional anemia, it is also true that in practiy all such work the intake of the basal diet, coning generally of milk or milk solids, is not under

this diet is consumed the slower does hemoglobin regeneration proceed.

Since female rats in general grow at a slower rate than male rats and presumably consume less food per day, the question naturally arises whether the sex difference noted by H. S. Mitchell and later by Smith and Otis is a primary difference in iron or copper metabolism, or whether it is merely a sequel of a primary difference in growth impulse.

The experimental results summarized in Table 1 bear directly upon this question. In experiments 1 to 4

TABLE 1

THE RESULTS OF SOME ANEMIA EXPERIMENTS INVOLVING THE COMPLETE CONTROL OF FOOD AND SUPPLEMENT INTAKE BY PAIRED RATS

xperiment number	Length of experiments weeks	Metallic supplements to basal milk diet	Number of pairs	Average daily intake of dried milk grams	Body weights		Hemoglobin in blood		Average change in hemoglobin level gms 100 cc	Probability of a chance outcome
					Average initial grams	Average final grams	Average initial gms 100 cc	Average final gms 100 cc		
		Constant daily dose of iron and copper								
1	2	.2 mg Fe + .02 mg Cu	6	6.65	96	140	5.90	10.25	+4.35	.0033
	2	" " " " " "	6	4.43	97	105	5.95	12.20	+6.25	
2	4	.5 mg Fe + .05 mg Cu	7	7.45	72	155	4.50	15.20	+10.70	.16
	4	" " " " " "	7	4.97	73	112	4.46	16.00	+11.54	
		Constant daily percentage of iron and copper								
3	2	.004 pct. Fe + .00016 pct. Cu .	7	6.92	94	127	5.53	11.83	+6.30	.015
	2	" " " " " " .	7	4.61	94	100	5.57	12.86	+7.29	
4	2	.008 pct. Fe + 00032 pct. Cu .	8	6.13	68	108	4.23	13.92	+9.70	.0019
	2	" " " " " " .	8	4.09	68	81	4.30	15.14	+10.84	
		Sex comparison on equal food (fresh milk) intake								
5	4 to 6	No supplements—males	6	...	63	115	11.75	6.53	–5.22	.085
	4 to 6	" " —females ...	6	...	63	125	12.20	8.17	–4.03	

trol. It seems to be the general opinion that only intake of the remedial supplements needs to be trolled, the implication being that a variable intake the nutrients of milk, which favor the production anemia, will not modify either the rate with which anemic condition develops or the rate with which is corrected. However, in 1930 Nevens and Shaw[2] blished a note in this journal in which evidence was mitted that "animals consuming large amounts of lk became anemic more quickly than those limited small amounts." They used the paired feeding thod, involving the feeding of equalized amounts of lk to each of a series of carefully selected *pairs* of s.

We have fully confirmed the results of Nevens and aw and have shown further by the paired feeding thod that the response of anemic rats to metallic pplements, in certain concentrations at least, is dified to some extent by the rate of consumption the basal anemogenic diet, such that the more of

[2] SCIENCE, 72: 249, 1930.

inclusive, the basal diet was dried whole milk (Klim). In experiment 5 the basal diet was fresh whole milk. In experiments 1, 2, 3 and 4, one rat in each pair was fed the milk solids *ad libitum,* while its pair mate received two thirds as much as was voluntarily consumed by the first rat. In experiments 1 and 3 the iron and copper supplements were fed in equal daily doses, as indicated, to all rats. In experiments 2 and 4 the supplements were incorporated in the milk solids in the proportions given. The rats in the first four experiments were made anemic by the Elvehjem and Kemmerer method in a prefeeding period. In experiment 5 the rats were taken directly from the stock colony and pair mates were fed equal amounts of whole milk with no supplements. In all experiments rats were paired with reference to initial weight and initial hemoglobin concentration of the blood. In experiments 1 to 4, pair mates were of the same sex, while in experiment 5 each pair consisted of a male and a female, taken, with one exception, from the same litter.

The results of experiment 1 show that a daily dosage of .2 mgm of iron and .02 mgm of copper promoted a more rapid regeneration of hemoglobin in those rats receiving the smaller intake of milk solids. In only 2 weeks of feeding a difference in recovery concentration of almost 2 grams of hemoglobin per 100 cc of blood developed. In all six pairs the rat on restricted intake recovered the more rapidly, and the probability[3] that this is a fortuitous result is so small (.0033) that it may be neglected. However, in experiment 2, with a daily supplement of .5 mgm of iron and .05 mgm of copper, the result is indecisive, even after 4 weeks of feeding. In 5 of the 7 pairs the rat on restricted food recovered from its anemic condition more rapidly than its pair mate, but in 2 pairs the reverse was true; the statistical analysis ($P = .16$) indicates that the outcome may have been a fortuitous one. These two experiments on the effect of a variable intake of milk solids are quite analogous to the experiments of Smith and Otis on the comparison of male and female rats in the sense that significant differences were noted only when the supplements were such as to promote a submaximal rate of recovery. They are also in agreement with the theory previously proposed[4] by one of us concerning unbalanced rations, that "the more of them is consumed the poorer nourished will be the animal with reference to the functions with respect to which the rations are unbalanced." Confirmation of this theory has already[5] been reported with rachitogenic diets: the greater the rate of consumption of such diets, the more rapidly does rickets develop. Vitamin B_1-deficient diets are also the more toxic the more of them is consumed,[6] as are also diets deficient in vitamin C.[7]

Experiments 3 and 4 show in both cases that for the particular iron and copper concentrations incorporated in the milk solids, the rats on restricted intake recovered significantly more rapidly than the rats on one half again as much food. It may be said that the concentration of iron used in this experiment (.008 per cent.) was lower than that consumed by the restricted rats in experiment 2 (.010 per cent.), but higher than that consumed by the unrestricted rats (.0067 per cent.).

Unfortunately we have not performed a curative experiment with pairs of male and female rats receiving equal intakes of milk solids. However, the r of development of anemia in paired male and fem rats receiving equal intakes of fresh milk was stud in experiment 5. In feeding periods lasting from 4 6 weeks, no significant differences were obtain although in 4 of the 6 pairs the female rat was slower in developing an anemic condition. The prob bility of a chance outcome, .085, is however too la to disregard. It will be noted also that on equal i takes of food the female rats gained less in bo weight ($P = .046$), and from available information may be assumed that their gains contained less protein, more of fat and less of blood.

It may be concluded that the sex difference in t development of nutritional anemia noted by H. Mitchell, as well as that in the recovery from nu tional anemia noted by Smith and Otis, may be p tially or entirely the result of a greater intake of t anemogenic basal diet by male rats. To that ext it is merely a sequel of the well-established differen in growth impulse between the male and the fem sex. In the same manner, the frequently observed d ference between male and female rats in the rate calcium retention and of the calcification of the bo has been traced in this laboratory[8] to the great demand for, and consumption of, food by the male.

The control of food intake by comparative anim in nutrition experiments according to some sche adapted to the problem at hand will generally simpli their interpretation and will make possible a demo stration of a fact or a principle where lack of cont can at best establish only a variable degree of prob bility in favor of it.

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CRYSTALLINE CATALASE[1]

WE have prepared crystalline catalase from be liver. Our method consists essentially in extracti chopped liver wth dilute dioxane, adding more dioxa to the extract to precipitate impurities and then p cipitating the enzyme through the addition of s more dioxane. The precipitated enzyme is dissolved water and crystallizes upon adding ammonium sulfa and cooling. Crystalline catalase has been obtain also from the extracted liver residue by fractionati extracts with ammonium sulfate solution.

Our catalase crystals are slender plates of mic scopic size. Presence of the crystals can be observ by rotating the liquid in which they are suspended a

[3] "Student," *Biometrika*, 6: 1, 1908.

[4] H. H. Mitchell, SCIENCE, 80: 558, 1934.

[5] W. E. Watkins and H. H. Mitchell, *Poultry Sci.*, 15: 32, 1936.

[6] G. Amantea and associates, *Atti Accad. Lincei*, 18, 317, 399, 1933; *ibid.*, 20: 134, 1934; *ibid.*, 22: 173, 1936; taken from *Chem. Abst.*, 28, 3764, 1934; 29: 1138, 1935; 30: 6422, 1936. H. G. K. Westenbrink, *Arch. Neerland. physiol.*, 19: 94, 1934; *Ber. ges. Biol.* Abt. B: *Ber. ges. Physiol. u. Pharmakol.*, 79: 585, 1934.

[7] V. Famiani, *Atti accad. Lincei*, 20: 129, 1934; *Chem. Abst.*, 29: 1138, 1935.

[8] B. W. Fairbanks and H. H. Mitchell, *Jour. Nutr.*, 1 551, 1936.

[1] From the Department of Physiology and Bioche istry, Medical College, Cornell University, Ithaca, N York.

bserving the thryxotropy. The crystals stain with ethyl violet and are fairly soluble in water. Their ilute solution is yellow. Their concentrated solution brown and gives an absorption band in the red at 27 m μ and a fainter band in the green at 536 m μ.

Catalase can be recrystallized easily by dissolving he crystals in dilute phosphate buffer of pH 7.3, ringing the pH of the solution to approximately pH .4 through the addition of acid potassium phosphate nd then adding ammonium sulfate slowly with cool- ng. The crystals form very rapidly.

One sample of twice recrystallized catalase, after issolving in phosphate buffer and dialysing until free from ammonium sulfate, was found to possess a *"Kat. f"* of 43,000 and an iron content of approximately 0.10 per cent. Crystalline catalase coagulates upon heating and gives many of the usual protein tests. A strong odor of burnt hair is produced on ashing. The pyridine hemochromogen test is readily obtained.

The properties of our crystalline catalase are in complete agreement with the properties of the catalase preparations of von Euler and Josephson,[2] and Zeile and Hellström.[3]

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF SYNTHETIC RESINS IN THE PREPARATION OF PERMANENT BACTERIAL MOUNTS

THE most common method employed in making permanent preparations of bacterial mounts entails the se of Canada balsam, a naturally occurring resinous ubstance. It serves as a cementing agent and, when pread upon a glass slide, seals the thin cover slip placed over the mount to protect and preserve the atter for subsequent observation. When permanent mounts are prepared in this manner, several days may be required before the solvent has completely evaporated, leaving a hard cement. In recent years, several synthetic resins have been prepared commercially, solutions of which harden rapidly on exposure to air, giving a hard, clear, colorless layer possessing a refractive index very close to that of glass. Coatings prepared by these resins adhere tenaciously to glass surfaces.

In determining the applicability of these resins, bacterial smears were made on glass slides and stained with dyes commonly used, including crystal violet, carbol fuchsin, methylene blue and the Gram stain. Preliminary investigations indicated that butyl acetate, free of acetic acid, was the most desirable of the organic solvents used. With one resin ("Pontalite"), xylol was substituted for butyl acetate with success. The solutions employed were between 15 and 20 per cent.

Mounts were made in two ways. First, solutions of the synthetic resins were substituted for Canada balsam as the cementing medium. The resin was used in exactly the same manner as the balsam, that is, a drop or two of the solution was placed upon the smear and a glass cover slip placed over it, care being exercised not to include air bubbles. The cover glass was pressed down lightly and the preparation ready for use after ten minutes of air drying.

Secondly, a solution of the resin was applied by tilting the glass slide bearing the mount, lengthwise, at a 45° angle, flooding by means of a dropping pipette and permitting the excess solution to drain off, thus leaving a thin, smooth, glass-like layer of uniform thickness. This may air dry for thirty minutes or more, before being used for observation or, if required at once, drying can be forced by baking the slide at 135° C. for five minutes with no apparent damage to the mount. No cover slip is used, the thin film of resin serving in its stead. When observing mounts prepared in this manner with the aid of the oil immersion objective, xylol can not be used to remove the cedar oil from the slide because of its solvent effect on the resin. The oil can be removed by washing off with ligroin, gasoline or mechanically by merely wiping off with lens paper. Mineral oil, which is often employed as the immersion medium, is much easier to remove from the slides than is cedar oil. If used a great deal, the thin resin layer will eventually become scratched. These scratches can be erased by covering with another film of the resin.

Slides were prepared in February, 1936, in the manner indicated above, using two commercial resins.[1] Each slide was divided into four portions consisting of mounts covered with (a) Canada balsam and a cover slip, (b) the synthetic resin and a cover slip, (c) the synthetic resin alone and (d) an uncovered portion. Over an eleven-month period there has been no noticeable change, such as fading due to the solvent action of the butyl acetate, in any of the covered preparations. Those under the synthetic resin appear as stable as those preserved under Canada balsam.

[2] H. von Euler and K. Josephson, *Liebig's Ann.*, 452: 158, 1927.

[3] K. Zeile and H. Hellström, *Zeit. physiol. Chem.*, 192: 171, 1930.

[1] "Vinylite" (Series A Resin), Carbide and Carbon Chemicals Corporation, New York; "Pontalite," du Pont de Nemours and Company, Wilmington, Del.

Solutions of these resins were also used in making permanent mounts of moulds. The slide was first covered with a uniform layer of the resin in precisely the same manner as described above. The film was then air dried for two to three minutes, at the end of which time it still presented a slightly sticky surface. This surface was then impregnated with the fungus in one of two ways. Either the resin side of the slide was laid gently on the colony, removed and air dried, or a portion of the colony was "fished out" with a platinum loop and these fragments placed on the partially solidified resinous layer, allowing the latter to air dry. Then, employing the methods of the mycologist, the organism was fixed, using any solution which has as a solvent, water, *e.g.*, mercuric chloride—formaldehyde solution. A fixing agent having an organic solvent can not be used because of its effect upon the resin. The preparation was then stained, applying any of the dyes used in aqueous solution, such as safranin, erythrosin or fuchsin.

It is believed that the application of the synthetic resin is superior to the use of Canada balsam from the standpoint of ease of manipulation, simplicity, rapidity and cost.

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A PRACTICAL DEVICE FOR THE RAPID QUANTITATIVE DETERMINATION OF PLANT PIGMENTS

IF the wave-length of the light employed in measuring the absorption of light by a solution is restricted to one of the absorption bands of the solution, the specific transmissive index, symbolized by k, is expressed closely by the equation,

$$k \equiv -\log_{10} T,$$

in which T is the transmittancy.

If, for practical reasons, the wave-lengths of the light employed can not be restricted to a single absorption band, the relation between the light absorbed and the concentration can not be expressed in so simple a manner. The relative transmission can, however, be plotted against the relative concentration; and the concentration of an unknown solution can be determined from the known relative transmission. Evidently, the ideal conditions should be approached as nearly as possible.

In the device we employed, a filter was used, that permitted the passage of only the light having wave-lengths ranging from 4,000 to 5,000 Angstrom units. All three plant pigments have absorption bands in this region. The filter was very dense, so that it was necessary to use a powerful light source.

A standard projection lantern having a 500-watt lamp was used. The condenser lenses and the projection lens were set so that the beam of light that fell upon the absorption cell containing the solution was plane parallel. The absorption cell was the kind used in spectrometry. It was in the form of a parallelopipedon and was closed with a glass stopper. Two such cells were mounted in such a manner that the one could quickly be interchanged for the other. The transmitted light was registered by means of a microammeter which recorded the current produced by a photronic cell after being excited by the transmitted light. When the two absorption cells were filled with water, they registered equally 50 arbitrary units when they stood in the same relative position with respect to the optical system and the photo-electric cell.

In practice, one cell was filled with water and the other with the solution to be studied. By means of a shutter device, the light fell upon the absorption cell for only a short time while a test was being made. The light source was kept constant by properly balancing the electrical system. The water reading was made before and after each solution reading. When the solution reading was multiplied by 2 the percentage transmission was obtained when referred to water, since the water was 50.

Standard solutions were prepared for all three plant pigments, using the pure chlorophyll, xanthophyll and carotene. The solutions ranged in intervals of 2.5 per cent. from 0 to 10 per cent., and in 5 per cent. intervals from 10 per cent. to 100 per cent. The 100 per cent. chlorophyll solution represented 5 milligrams per 100 cc of solution, while the 100 per cent. for the other two pigments represented 0.5 milligrams per 100 cc of solution. The values obtained were plotted against the known concentration, and a graph for each pigment was drawn. From the graphs, tables were made that made it possible to read quickly the concentration of any unknown solution from the relative per cent. transmission. Care was taken that all parts of the instrument were constantly in the same position.

The probable error was calculated and was found to be less than 2 per cent.

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